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THESIS

AN APPROACH TO VALIDATION AND VERIFICATION OF THE COMMUNICATIONS LOAD MODEL WITH SUPPORTING USER'S GUIDE

by

William Robert Cox

September 1987

Thesis Advisor: Carl R. Jones

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An Approach to Validation and Verification of the Communications Load Model with Supporting User's Guide

by

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B.S. Biology, San Diego State University, 1977

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN INFORMATION SYSTEMS

from the

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September 1987

ABSTRACT

This thesis investigates the issues of validation and verification of the Communications Load Model (CLM) being used in the Battle Group Communications Simulation Facility at the Naval Air Development Center. The processes involved in creating user input files are explained and evaluated. A user's guide is included to assist the user in interpreting input into the proper data structure and format for use by the model. Structure and function of the model and its components are examined. Calculations of results predicted by scenario inputs are compared to actual program output. The analysis is used to determine appropriate methodology to be utilized in validation and verification of the CLM.

Thesis
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I. INTRODUCTION

The ever increasing complexity of the modern tactical battlefield environment poses many problems to the armed forces of the United States and its allies. In order to mount a campaign with any chance for success the sustained operation of communication, command and control (C^3) links between all of the deployed forces is required. Not only must such a linking network be sustainable in the midst of a hostile electronic environment, it must be secure and free from interception and intrusion. Design, testing and implementation of a network system meeting these requirements can be a long and costly process.

The need for a system simulation model to serve as a test bed for evaluation of proposed network designs led to the development of the Communications Load Model (CLM). Use of such a model for design specification evaluation offers a means of reducing the risk of funding full-scale development of tactical communication systems. This thesis examines the potential usefulness of the CLM as a development tool and investigates the approach to validation and verification of the CLM.

Originally developed to support Air Force efforts on the Joint Tactical Information Distribution System (JTIDS), the CLM is now undergoing further development at the Naval Air

Development Center (NADC) for use in the Navy's current JTIDS project. The CLM has been extensively modified from its original configuration in order to accommodate a wider variety of communication network specifications.

The CLM is actually a system made up of separate programs that together perform a complex set of functions. User developed input data files supply descriptions of force units, capabilities, and instructions for force group campaign activities. The CLM performs a wargame simulation based on the input data and produces a chronologically tagged file of action states resulting from the outcome of the campaign events. These action states are used to trigger message events as defined by communication doctrine specified by user input. The resulting message load is applied to the Communication System Model where the impact of the load may be evaluated for different network design specifications.

Major functions of the CLM include kinematics, detection, response, attrition, and communication. The first four functions named are involved in the events of the wargame simulation. The communication function is handled by the Communication System Model, receiving the action state information output from the wargame simulation.

With the planned configuration of the CLM still under development, NADC, in seeking support for this development effort, has offered to sponsor thesis research work at the

Naval Postgraduate School (NPS). In a memo dated 22 OCT 1986, by LCDR Neal Hesser, director of the Information Transfer Systems Program at NADC, "Verification of the Communication Load Model" is proposed as a topic for thesis research. As stated in the memo, "areas for thesis work include scenario development and validation, mission directive verification and validation, message coupling verification, and force group action simulation verification and validation".

The intent of this thesis is to investigate the structure and function of the CLM in order to determine the best approach to the validation and verification process and lay the groundwork of support for these efforts to be undertaken as follow-on thesis projects. A user's guide for creation of input data files is included in this thesis to facilitate working with the CLM.

A scenario was designed during this study to use in evaluation of the CLM functions. Data output from running the scenario are examined and compared to expected results. This analysis is used to illustrate the methods necessary to perform validation testing of the CLM functions.

The organization of this thesis is arranged to give the reader a basic familiarization of the CLM and then build on that understanding by examination and explanation of the components of the model and how they function. Chapter II contains background information on the CLM and describes its overall structure and organization. Chapter III describes the methodology employed in carrying out the different phases of this project. Chapter IV contains descriptions of the input data sets used for the scenario and gives an analysis of expected versus actual results from the scenario. Chapter V addresses the issues of validation and verification of the CLM functions. Chapter VI offers conclusions and recommendations. Appendix A contains a user's guide to facilitate the creation of user input data files. Appendix B contains the CLM input and output data files.

II. THE COMMUNICATIONS LOAD MODEL

The purpose of the CLM is to convert a tactical military scenario into realistic communication traffic loads for the evaluation of network management schemes. While the CLM was originally intended for application to the development of the Joint Tactical Information Distribution System (JTIDS), continued development and modification are intended to make the CLM suitable for application to the general tactical communication network problem.

A. CLM BACKGROUND

The Communications Load Model (CLM) is a set of computer programs originally developed for the Joint Project Office (JPO) at Hanscom Air Force Base, MA. The CLM development by MAR, Incorporated of Rockville, MD, under contract to the JPO, was begun in October, 1979. The Development of two ancillary programs, the Events Simulation Module (ESM) and the Link Evaluation Simulator (LES) were subcontracted to Network Analysis Corporation, a subsidiary of ConTel.

The initial development phase continued until 1982. It was in 1982 that the Naval Air Development Center received a set of CLM programs from the JPO at Hanscom AFB. The CLM had not, at that time been tested or verified. It was not delivered as a finished product, and the programs comprising the CLM were not integrated into a single working system. It had not, to that date, been utilized for any specific purpose in conjunction with JTIDS or any other system.

In conjunction with the initial efforts to utilize the CLM at NADC, a contract was made with MAR, Incorporated, in 1982 to provide program documentation for the CLM. The primary documents provided under this contract were the Communications Load Model (CLM) Computer Program Development Specification and the User's Manual For The Communications Load Model (CLM).[1]

The first task facing the NADC C³ Lab in its effort was the conversion of the programs to a format compatible with the VAX/UNIX environment and its particular version of FORTRAN 77. The CLM had been developed on a Data General model S-230 computer, written in FORTRAN V, a much more restrictive environment with respect to memory capacity as compared to the VAX system in the C³ Lab at NADC. Once the conversion was complete in September 1982, the programs, as installed on the VAX/UNIX system, and the MAR, Incorporated, 1982 documentation became what is referred to in this work as the baseline version of the CLM.

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[1] Background information obtained in interviews with Mr. Fred Mill of BDM Corporation, formerly of MAR, Incorporated.

B. CLM PROGRAM COMPOSITION

The description of the CLM given here will consist of the configuration and function of the baseline version, followed by changes that have been implemented and changes that are planned. The following description of the baseline version is based on information drawn from the program specification [Ref. 1] and the user's manual [Ref. 2].

The configuration of the CLM version delivered by MAR in 1982 is that of a system of six programs and their associated input and output files. The six programs that comprise the CLM are composed of two hundred twenty-one subroutines and more than twenty-one thousand lines of FORTRAN code. Listed in order of execution, the six programs are:

1. PREPROCESSOR
2. PREWAR
3. WARGAM
4. PREGEN
5. CLG
6. POST PROCESSOR

A brief description of each program and its associated input and output files will be presented here.

1. PREPROCESSOR

This program is composed of 46 subroutines with 7,654 lines of FORTRAN code. The function of PREPROCESSOR is to accept user input data files, perform checks, extract data and prepare input data files in an acceptable form for the PREWAR and PREGEN programs.

The user input files, DATBAS, SENSET, and CONDAT are checked for correct formats, data types, legal value ranges, and completeness. A description of these user input files is included in part C of this section. Once the checks have been successfully completed, raw data are extracted to produce the output files RAWGAM and RAWCLG, which are supplied as input files to the PREWAR and PREGEN programs, respectively.

An additional output file, PROUT, is also produced as a diagnostic aid. In the event that the PREPROCESSOR does not successfully complete its run, an error message will be displayed. The file PROUT contains tables that indicate in which input file(s) the error(s) occurred and displays information on data category, field and type of error for each error encountered.[2] PROUT is an extremely useful tool for debugging user input files.

2. PREWAR

This program is composed of 10 subroutines with 1,156 lines of FORTRAN code. The function of PREWAR is to accept the file RAWGAM from PREPROCESSOR and create all the linkages between entities and attributes to be utilized in WARGAM. PREWAR produces the output files SMTHGM and MISSDR, smoothed wargame inputs and mission directives, respectively, in binary readable form for input to the program WARGAM. Off-line printout is provided in the file PWOUT.

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[2] Refer to Table B-5, Appendix B for PROUT example.

3. WARGAM

This program is composed of 96 subroutines with 8,059 lines of FORTRAN code. The function of WARGAM is to accept the files SMTHGM and MISSDR from PREWAR and simulate the campaign activities of the scenario by executing the mission directives as prescribed by the user input data. WARGAM produces the output files ASRCRD, EVENTS, and WGOUT, which are the action state records, chronological campaign events, and the off-line printout, respectively.

4. PREGEN

This program is composed of 8 subroutines with 517 lines of FORTRAN code. The function of PREGEN is to accept the RAWCLG file from PREPROCESSOR, the SMTHGM file from PREWAR, and the ASRCRD file from WARGAM, and create all the linkages between the entities and attributes to be utilized in the communication load generator (CLG). PREGEN produces the output files SORTAS and SMTHLG, sorted action states and smoothed message inputs, in binary readable form for input to CLG, and the file PGOUT for off-line printout.

5. CLG

This program is composed of 48 subroutines with 2,916 lines of FORTRAN code. The function of CLG is to accept the files SORTAS and SMTHLG from PREGEN and generate a message load in accordance with prescribed communications doctrine. CLG produces the message event file, MSGENT, the force unit relative position file, URELPS, a file of time-tagged group positions and velocities, GRUPOS, and the file CGOUT for off-line printout.

6. POSTPROCESSOR

This program is composed of 13 subroutines with 815 lines of FORTRAN code. The function of POSTPROCESSOR is to accept as input the files DATBAS, SENSET, RAWGAM, SORTAS, MSGENT, URELPS, and GRUPOS and produce ESMFIL for use in the Event Simulation Model (ESM). The ESM is a time division multiple access (TDMA) network simulator developed by ConTel to evaluate proposed JTIDS configurations.

C. CLM INPUT FILES

Input to the CLM is achieved by way of user created data files. The two files which make up the user interface to the CLM are DATBAS and SENSET. All of the information necessary to construct forces and campaign activities is entered in these two input data files.

In the baseline configuration of the CLM, there is no "user friendly" interface mechanism to facilitate the entry of user data into the input files. In conjunction with the FORTRAN environment of the CLM programs, the input files are constrained to the 80 column punch card format. The user must, therefore, have not only a precise knowledge of the forces, units, and capabilities to be utilized, but must also have a complete understanding of the data structures necessary to express that information as input acceptable to the programs. A misplaced decimal point or failure to pad out a field with blank spaces can have disastrous results. A brief description of the input files will be presented here.

1. DATBAS

This file is designed to be a single resource data base for use in all scenarios. User defined forces, unit types, and capabilities are entered into DATBAS. As the number of entries increases, DATBAS may be used as a catalog from which many scenarios may reference any or all of the definitions contained therein.

The basic element employed in the scenario modeled by the wargame is the force unit. Capabilities for weapons, sensors, communications and jamming are assigned by user input to each unit type defined in DATBAS, as are other attributes such as unit size, speed, and priority as a target.

Units may be designated as members of force groups. Each force group has user assigned attributes such as type of group, home base, chain of command, and radius of dispersion.

Force groups may be designated as members of super groups. This arrangement is useful when several force groups are deployed in formation.

For a detailed description of DATBAS structure and usage refer to the User's Guide in Appendix A.

2. SENSET

This file contains the user input parameters that describe the campaign activities to take place in an individual scenario. A separate SENSET file must be constructed for each scenario. Preplanned campaign activities to be carried out by each group in a scenario are specified as mission macro instructions and mission directives in the user input file SENSET. In addition to the preplanned campaign activities, defensive reaction activities are initiated automatically in the program WARGAM. Each of these campaign activities results in an action state record that is stored in a chronological file.

For a detailed description of SENSET structure and usage refer to the User's Guide in Appendix A.

3. CONDAT

An additional input file, CONDAT, supplies data for program execution control to all of the programs with the exception of Postprocessor. The data contained in CONDAT directs the flow of input and output files between the programs during the sequential execution of the CLM.

D. CLM OUTPUT

The ultimate product of the CLM is a stream of message events that are related to the campaign activities of forces as modeled in the wargame. The message events are driven by communication doctrine as prescribed by the user, and may represent the transmission of a single-send message, the initiation of a periodic stream of repetitive messages, or the termination of a periodic stream of repetitive messages.

Communication doctrine specified in the user input file DATBAS causes specific message types to be sent by designated units as a result of specific action states. Thus the combined message traffic of all units participating in a given scenario generates the communications load used to evaluate system capacity, function, and response.

E. CLM CHANGES

The first change to the overall functional design of the CLM was made due to the fact that the ESM and LES programs had never been properly interfaced to the CLM. As a result, there was no attempt to utilize these programs at NADC. Since the Postprocessor program of the CLM was designed to provide input specifically for the ESM, it was rendered essentially useless and omitted from the normal runtime configuration of the CLM.

A much needed improvement to the process of creating DATBAS and SENSET files is currently under development. A user interface consisting of two menu-driven editors isolates the user from the details of data structures. The implementation of this "user friendly" interface will do much to facilitate creating and editing the user input files. Future plans include the integration of this interface into a new preprocessing module to replace the existing PREPROCESSOR.

A new set of programs to provide the postprocessing capabilities necessary for network modeling and analysis are currently under development by the C^3 Lab at NADC. In order to provide proper interfacing with the new postprocessing facilities, the programs PREGEN and CLG (Communication Load Generator) have been replaced by two new programs, PreASG and ASG (Action State Generator) respectively.

The function of PreASG is to accept the output from WARGAM, sort the mission events and send the files SORTAS and SMTHLG to the program ASG.

The function of ASG is to expand force group tracks into individual platforms thus providing unit resolution, provide Killed In Action information on each unit, and provide a chronological file of group positions and velocities, GRUPOS. Action states, in the file ACTION, and their coupled message events, in the file MSGENT, along with GRUPOS make up the interface to the new postprocessing facilities of the CLM.

The changes in the programs have necessitated some changes in the input data files DATBAS and SENSET. Categories within these files have been added, deleted or modified as required to accomodate the program changes. These changes are noted in the detailed descriptions of the data stuctures in the User's Guide in Appendix A. Most of the data changes are the result of changes in the manner in which simulated message traffic generation is handled in the programs.

There is no coherent body of documentation for the programs that comprise the postprocessing section of the CLM. Information upon which the following descriptions are based is drawn from material prepared for briefing presentations, informal design notes, and interviews with personnel involved in the development effort in the C^3 Lab at NADC.

One of the postprocessing programs that is already functional is the graphic display package. The program, NEWVLT (Video Look-up Table), is written in C programming language and includes modules that generate output for geographic, message loading, and network capacity displays. The output is used to drive a RAMTEK 9460 color graphic display system connected by DMA channel to the VAX system.

The geographic display presents a grid of 20 degrees longitude by 15 degrees of latitude upon which force dispositions are displayed. Force movements and actions are displayed as the scenario is played according to mission macro instructions and mission directives. Sensor detections, track reporting, and message traffic between units are displayed as color coded vector lines between the units involved.

The message loading and network capacity displays are represented as line graphs. Individual lines within the graphs are color coded to depict message loads generated by specific events or a related set of events.

Two postprocessing modules that are under development at this time are the Communication System Model and the Propagation Loss and Jamming Model. These two modules are intended to give the CLM the power and flexibility to evaluate the performance of a variety of communication networks under a wide range of conditions. Of these two modules, the Communication System Model is considered to be the main component for CLM postprocessing.

There is a set of utility programs that perform the task of conditioning data output from the ASG program of the CLM for use as input to the postprocessing programs.

The Propagation Loss and Jamming Model receives information on forces, positions, action states, and message events and produces a connectivity matrix. The matrix is intended to provide the status of connectivity between units expressed as a binary yes/no. Connectivity is based on the criteria of line-of-sight between units, signal strength, and jamming as determined by the input data. The connectivity matrix is provided as input to the Communication System Model.

The Communication System Model receives input from the Propagation Loss and Jamming Model, conditioned input from the ASG program and direct user inputs concerning Net Participating Groups (NPG) and the Capacity Run Limits of the network. The output of the Communication System Model is the Composite Message/Analysis file that has been tentatively named NETMESS.

The information input for Net Participating Groups includes definitions of group designation, group composition by unit type and number, communication capacity by platform, and NPG unit designated as Relay.

It is anticipated that the implementation of the postprocessing facilities will provide the CLM with the capability to evaluate the impact of multinet and joint service operations on network design and unit loading.

III. METHODOLOGY

The aim of this thesis is to examine the approach to validation and verification of the Communications Load Model (CLM). Additionally, the potential of the CLM as a development tool and training aid in Communication, Command and Control systems will be evaluated.

The CLM is a very large and complex model. The first step in approaching the problem of validation and verification is to attain a solid understanding of the model, its components, and their relationships. The methodology for accomplishing this will be described in this section.

Initial study of the CLM began with the receipt of program documentation in December, 1986 from LCDR Neal Hesser, JTIDS Project Officer at NADC. Documents received were the Communications Load Model (CLM) Computer Program Development Specification and the User's Manual for the Communications Load Model (CLM). As a result of telephone discussions in December, 1986 and January, 1987 with LCDR Hesser and Mr. Wayne Phillips, CLM project engineer in the C³ Lab at NADC, a determination was made to install the CLM at the Naval Postgraduate School (NPS). Installation was to be on the VAX 11/780 computer in the Wargaming Analysis and Research Laboratory (WARLAB) at NPS, as the CLM was already running on VAX 11/780 system at NADC. The only difference between the two VAX systems is the VAX at NADC uses the UNIX operating system, while the VAX at NPS uses the VMS operating system. This was not considered to be a major obstacle since both operating systems support the FORTRAN 77 programming language compiler.

In order to begin familiarization with the CLM and prepare for the planned installation at NPS, the author travelled to NADC at Warminster, PA from the 4th through the 6th of February, 1987. During this time, interviews were conducted with key personnel involved in the CLM development project. Briefings were also given on the structure, function, and operation of the CLM by Mr. Wayne Phillips. Observations were made of the CLM in operation while running the scenario Seawar 85. A complete set of CLM files was output to a tape backup unit in VMS format to be transported back to NPS.

Upon return to NPS, the task of installing the CLM on the VAX/VMS system in the Wargaming Lab began. The first attempt at compiling the FORTRAN source code failed. When the cause of the compile errors was determined, all of the program modules were edited accordingly. After the time consuming editing process was completed, all of the program modules compiled successfully.

Once compiled, the object modules were arranged into program libraries to be linked into executable code. At this point, many errors ocurred in the linking process, bringing progress to a halt. In an attempt to overcome these obstacles Mr. Wayne Phillips travelled to NPS to assist with the installation effort from 22 to 27 April, 1987. After approximately fifty hours of intense troubleshooting effort, very little progress had been made. At that point it was determined that installation of the CLM on the VAX/VMS system in the NPS Wargaming Lab would not be feasible within the time constraints of completing the research for this thesis. After careful consideration of the alternatives, it was decided that the best way to complete the research phase of this thesis effort would be to have a dedicated week of working time with the CLM on site at NADC. To accomplish this, the author spent the week of 15 through 19 June, 1987 at NADC. The activities of the week-long effort at NADC will be described here.

The plan of action for the evaluation of the CLM called for writing a new and untried scenario, running the scenario, and analyzing the performance of the CLM during the run and the results of the run.

The process of writing the scenario was to be evaluated and documented for the purpose of producing a user's guide as part of this thesis. The results of running the scenario were to be compared to the expected outcome based upon the scenario design. This comparison is to serve as the basis for approaching the issues of validation and verification of the CLM.

The first step taken in preparing to construct the scenario was to draw up a "game plan" outlining the type of events to take place, the number and types of units to be involved, and the disposition of the forces on the "playing field", which is laid out as a grid of 15 degrees of latitude by 20 degrees of longitude. Plotting this area on a piece of graph paper makes it much easier to plan mission routes and calculate distances and times required to execute mission macro instructions and mission directives. An example of the grid is shown in Figure 3-1.

An air strike by Blue forces against a Red Base is the scenario for this study. The Blue forces consist of an aircraft carrier and two air strike groups. Each air strike group is made up of four sections (pairs) of strike aircraft accompanied by fighters for defensive air cover, with six sections in the first group and four sections in the second group. The extra fighter sections in the first group are intended to absorb the first round of SAMs launched and engage the first wave of defensive fighters launched from the Red Base.

An air base and a collocated surface-to-air missile (SAM) base comprise the Red forces. Twelve sections of defensive fighters are assigned to the Red Base. Twenty missiles are assigned to the SAM base.

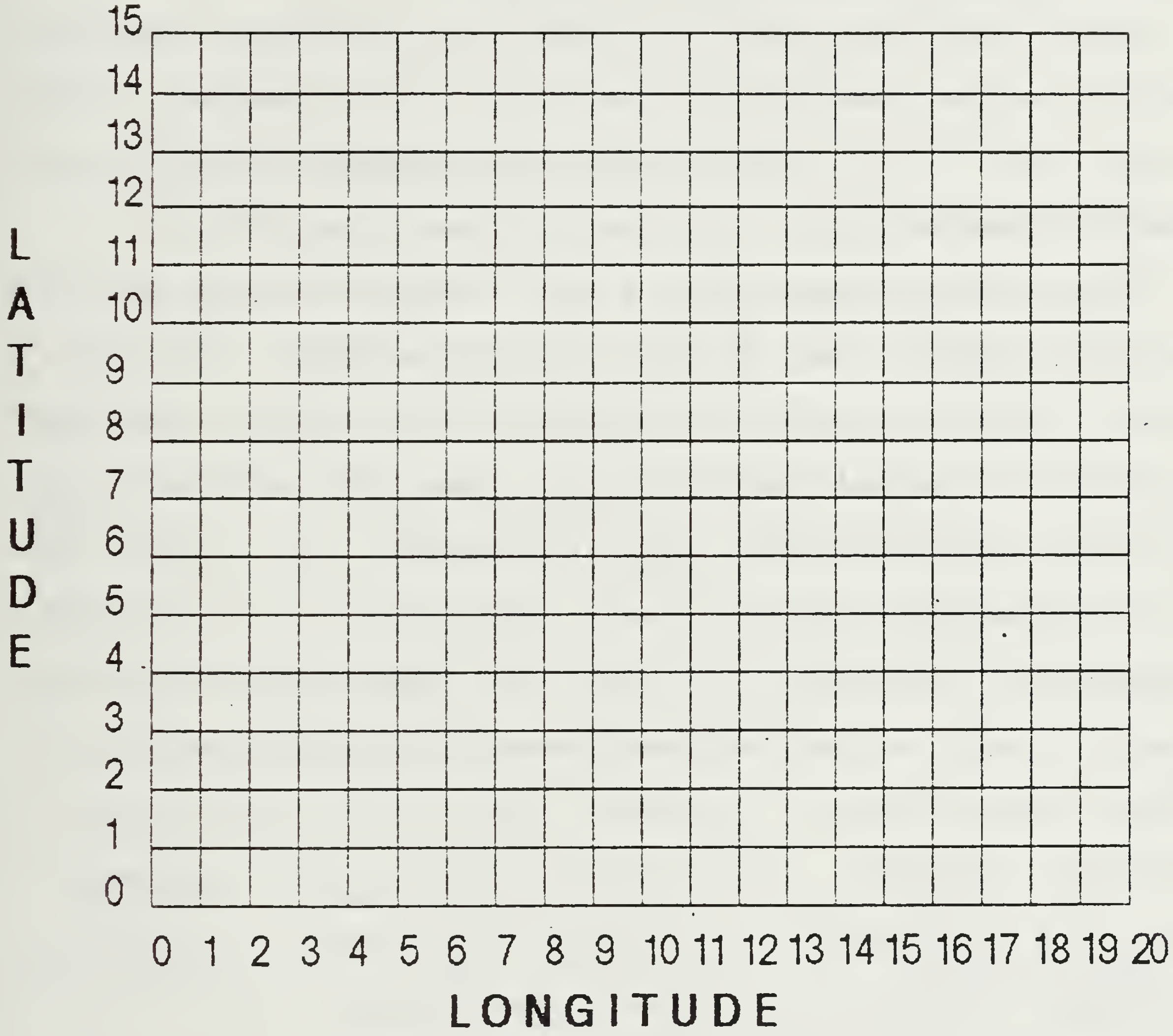

Figure 3-1. CLM Scenario Reference Grid.

With the scenario plan roughed out, the next step was to convert the plan to input for the files DATBAS and SENSET. Complete listings of these files with accompanying explanations are included in Appendix B.

After the input files were created, the command "RUNCLM" entered at the console set the model in operation. The console must be in the directory containing the DATBAS and SENSET files that are to be used for the current run.

When the CLM completes its run, output is available to be run through the graphic display facility, providing a visual representation of the action states generated by the scenario. Elapsed time for the wargame is displayed along with the actions of the forces on the grid. This allows for initial analysis of the scenario for correctness by visual inspection. Detailed analysis of the results of the scenario may be accomplished examining the wargame battle history in the output file WGOUT. This file contains time, position, velocity vectors and event type for all events occurring for each force group in the scenario. Selected listings of WGOUT are included in Appendix B.

Analysis and comparison of CLM scenario input with scenario output will serve as the basis for addressing the approach to issues of validation and verification of the CLM.

IV. DATA SETS

The data sets utilized for the construction of the user input files DATBAS and SENSET will be discussed in this section. The meaning of the data sets will be evaluated in terms of expected results in the scenario.

Output data of the actual results of the scenario run will also be presented in this section. Selected contents of the file WGOUT will be examined and their meaning explained in terms of the actual scenario events that occurred during the run. A complete listing of the file WGOUT will not be included, as it is 712 kilobytes in size and would add considerably to the heft of this document without adding commensurately to the illumination of the issues under consideration here.

A. DATBAS

This input data file contains the definitions for all of the force units and their capabilities. A summary of the forces involved in the Blue air strike vs. Red air base scenario is given in Table 4-1. The interpretation of these forces and their capabilities as DATBAS entries is presented in Table B-2 of Appendix B.

TABLE 4-1

SUMMARY OF FORCE COMPOSITION

Red Forces

1. Air base with 150 NM range radar and point defense.
2. 12 sections (total of 24) of defensive air fighters with radar and air-to-air weapon capabilities.
3. Long range surface-to-air missile site with 150 NM range radar and 20 SAMs with 90 NM maximum range. SAM site is collocated with air base.

Blue Forces

1. Aircraft carrier with point defense.
2. E-2 long range surveillance aircraft with 250 NM range radar.
3. 10 sections (total of 20) of defensive air fighters with radar and air-to-air weapon capabilities.
4. 8 sections (total of 16) of attack aircraft with radar, air-to-surface weapon, and air-to-air weapon capabilities.

B. SENSET

Data defining the actions to be taken by the forces involved in the Blue air strike vs. Red air base scenario are contained in this file. A complete listing of SENSET is included in Table B-3 of Appendix B. A narrative summary of the scenario events is presented here. Selected data from the wargame output file WGOUT are presented here for the purpose of comparison of actual results of the functioning of the CLM programs against the expected outcome based on program input. Calculations are based on equations utilized by the CLM programs as defined in the program specifications [Ref. 1].

Initial conditions have the Red Base fixed at position (10.00, 12.00) on the grid and the Blue Carrier starting at position (10.00, 3.00) on the grid as shown in Figure 4-1. All aircraft, both red and blue, are on deck at their base and carrier grid positions respectively.

With the Blue Carrier steaming north at 30 knots, the first event upon game initiation is the E-2 proceeding to station. Station for the E-2 is a north-south track 50 NM in length at 25,000 feet altitude, 240 NM north of the Blue Carrier.

C. COMPARISON OF RESULTS

Strike groups 1 and 2 must launch from the Blue Carrier at such time that following their respective strike routes, they will reach the target, Red Base, at 2.50 and 2.55 hours game time respectively, as prescribed by the mission macro instructions. Taken from WGOUT, Table B-5 in Appendix B shows that Strike Group 1 began its takeoff event at game time 0.983, with individual group (section) takeoff events from time 0.984 through time 0.990. Strike Group 2 takeoff

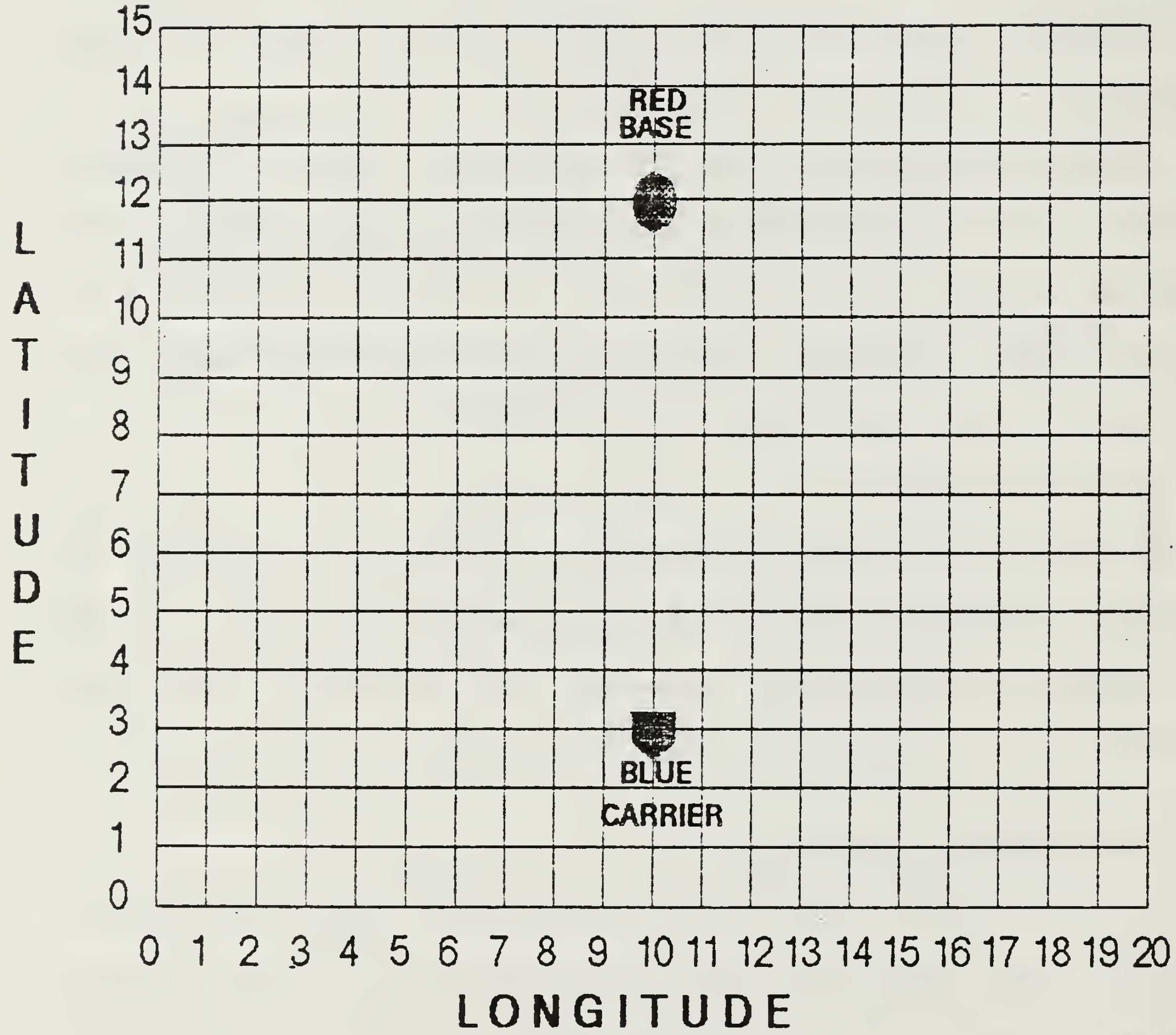

Figure 4-1. Initial Force Positions at Scenario Start.

begins at time 1.033 and is completed at time 1.040, also shown in the table.

Given that the strike routes both begin at position (10.00, 3.00) on the grid and run equal distances to the target, as shown in Figure 4-2, the start times on the strike routes are computed as shown in Table 4-2. Based on this calculation, the expected times for Strike Group 1 and Strike Group 2 to start on the strike routes are 1.06 hours and 1.11 hours respectively. Grid positions used in SENSET must be multiplied by 60 in order to be reconciled with group positions given in WGOUT .

TABLE 4-2

CALCULATED START TIMES FOR STRIKE ROUTES

Distance along strike routes : 689.12 NM

Mission speed of aircraft : 480 NM/H

Elapsed time on strike routes =

689.12 NM / 480 NM/Hour = 1.436 Hours

Game time at target for:

Strike Group 1 = 2.50 Hours

Strike Group 2 = 2.55 Hours

Game time to start on route for:

Strike Group 1 = 2.50 - 1.436 = 1.064 Hours

Strike Group 2 = 2.55 - 1.436 = 1.114 Hours

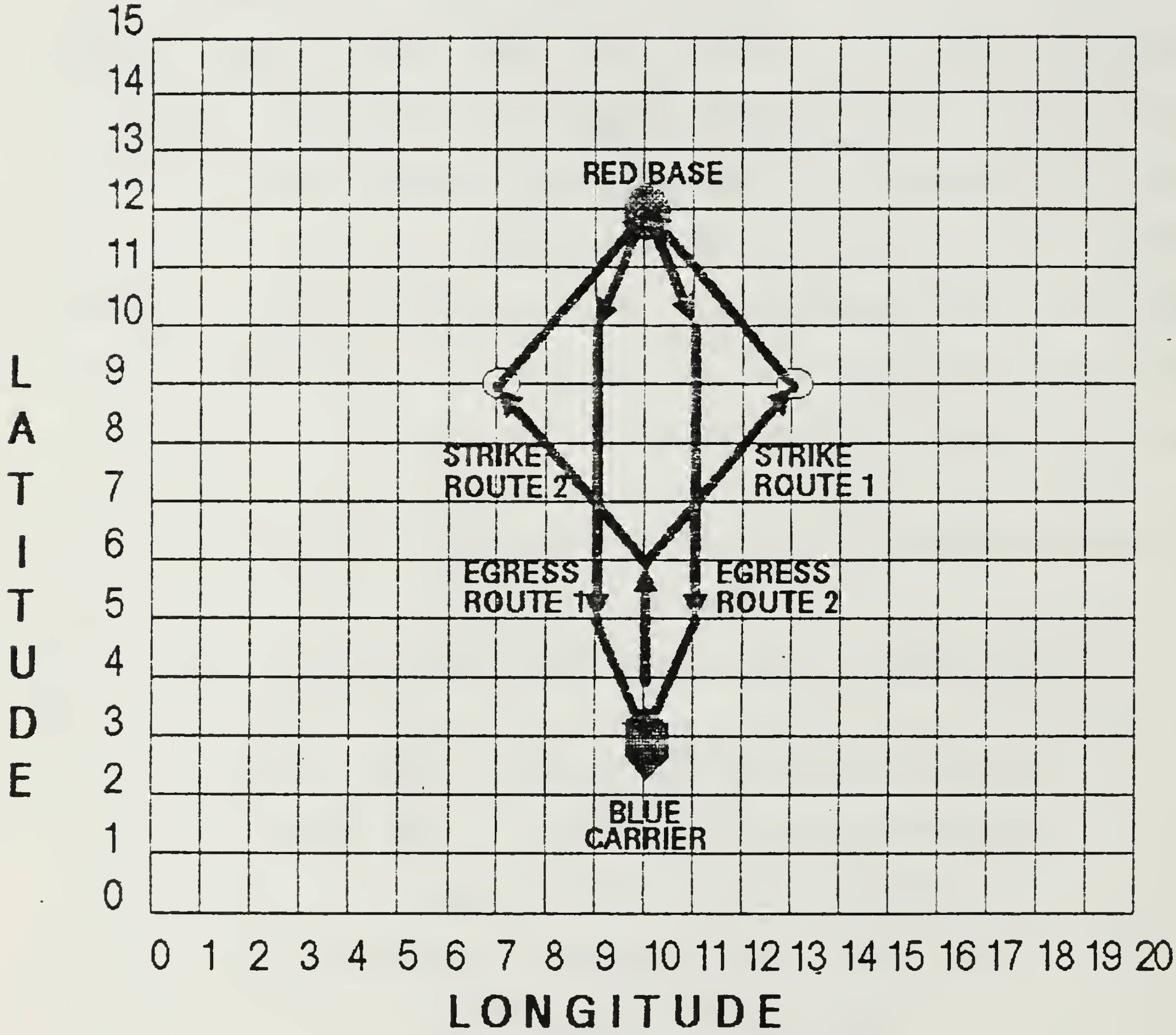

Figure 4-2. Blue Air Strike Routes.

As can be seen in comparing the calculated results from Table 4-2 with the actual output from WGOUT in Table 4-3, the strike route start times are very close. Minor differences of 0.018 hour for Strike Group 1 and 0.015 hour for Strike Group 2 can possibly be accounted for by the following reasons:

1. The program assigns each member of the group a separate takeoff event time. The "launching" and coordinating of the strike groups by the program is a very complex process.
2. Each group member is assigned an offset range and bearing from the center of the group. It is the time that the group center is at the route starting point that is given as the event time.

TABLE 4-3

ACTUAL START TIME FOR STRIKE ROUTES
(excerpted from WGOUT)

```
TIME 1.046  BLUE STK1 GRUP    2  MSSN EVNT      0
    BLUE GRUP XPOS 600.00   YPOS 180.00
         VELX 8.00   VELY -479.93

TIME 1.099  BLUE STK2 GRUP    3  MSSN EVNT      0
    BLUE GRUP XPOS 600.00   YPOS 180.00
         VELX 8.00   VELY -479.93
```

The level of game time resolution in conjunction with the effects of truncation and precision on the algorithms involved in these processes could also possibly contribute to this difference.

Calculating the time for arriving at the first turn point, located at (10.00, 6.00) on the grid, gives the values shown in Table 4-4.

Comparison of Table 4-4 against actual results given in Table 4-5 shows the same amount of difference in time at the first turn point as seen in the route entry time calculations, the initial difference just being carried along to this point. Calculated elapsed time is the same as the actual elapsed time for this leg of the route.

TABLE 4-4

EXPECTED GAME TIME AT FIRST TURN POINT

Predicted time for entering the strike routes:

Strike Group 1 at time 1.06 Hours

Strike Group 2 at time 1.11 Hours

Distance to first turn point = 180 NM

Mission speed = 480 NM/Hour

Elapsed time to first turn point:

180 NM / 480 NM/Hour = 0.375 Hour

Game time at first turn point for:

Strike Group 1 = 1.064 + 0.375 = 1.439 Hours

Strike Group 2 = 1.114 + 0.375 = 1.489 Hours

TABLE 4-5

ACTUAL GAME TIME AT FIRST TURN POINT
(excerpted from WGOUT)

```
TIME 1.421  BLUE STK1 GRUP   2  MSSN EVNT     0
    BLUE GRUP XPOS 597.00   YPOS 360.00
         VELX -8.00   VELY 479.93

TIME 1.474  BLUE STK2 GRUP   3  MSSN EVNT     0
    BLUE GRUP XPOS 597.00   YPOS 360.00
         VELX -8.00   VELY 479.93
```

At the first turn point, Strike Group 1 takes a 45 degree turn to the right, after which Strike Group 2 takes a 45 degree turn to the left. The strike groups proceed to their second turn points, located at (13.00, 9.00) and (7.00, 9.00) on the grid respectively, which are equidistant from the first turn point. For this leg, calculation of the times in Table 4-6 will use the actual times at the previous route point, from Table 4-5 as the start time. A comparison of only the calculated and actual elapsed times will be made.

Comparison of the calculated results in Table 4-6 with the actual times in Table 4-7 reveals that elapsed time for Strike Group 1 was 0.009 hours less than calculated while that for Strike Group 2 was 0.003 hours more than calculated.

TABLE 4-6

EXPECTED GAME TIME AT SECOND TURN POINT

Distance to Second Turn Point = 254.558 NM

Mission Speed = 480 NM/Hour

Elapsed Time = 254.558 NM / 480 NM/Hour = 0.530 Hour

Actual Game Time at First Turn Point for:

Strike Group 1 = 1.421 Hours

Strike Group 2 = 1.474 Hours

Predicted Time at Turn Point 2 for:

Strike Group 1 = 1.421 + 0.530 = 1.951 Hours

Strike Group 2 = 1.474 + 0.530 = 2.004 Hours

TABLE 4-7

ACTUAL GAME TIME AT SECOND TURN POINT
(Excerpted from WGOUT)

```
TIME 1.942  BLUE STK1 GRUP   2  MSSN EVNT     0
    BLUE GRUP XPOS 771.00   YPOS 540.00
         VELX 333.61  VELY 345.12

TIME 2.007  BLUE STK2 GRUP   3  MSSN EVNT     0
    BLUE GRUP XPOS 415.00   YPOS 540.00
        VELX -341.28   VELY 337.53
```

Another observation, which may be related to the time variation, is that the longitudinal position error is getting larger with each successive increment of travel. In comparing the XPOS data from WGOUT in Table 4-5, with the route point position specified in the RTE category in SENSET, the XPOS 597.00 should be 600.00 to agree. The specified position, (10.00, 6.00), corresponds to WGOUT values of XPOS 600.00, YPOS 360.00 when the values from SENSET are multiplied by 60.

Comparing the XPOS values from Table 4-7 with the specified route points from SENSET shows this positional error increasing. The increase is not uniform for the two different turn points, in spite of the fact that the route legs are mirror images of each other. To be correct for the position specified in the RTE category of SENSET, the second turn point on Strike Route 1 should be at XPOS 780, YPOS 540, corresponding to position (13.00, 9.00) in SENSET. As seen in Table 4-7, the XPOS is 771.00 which is 9.00 minutes of longitude or 9.00 NM less than the specified position. The second turn point for Strike Route 2 is shown to be XPOS 415.00, YPOS 540.00 in Table 4-7. In this case the XPOS should be 420.00 to be correct for the corresponding specified position in SENSET, which is (7.00, 9.00). The longitude of this turn point is also less than the specified position, by 5.00 minutes or 5 NM in this case.

It appears that the program considers the position was reached when the center of each strike group reached YPOS 540.00, executing the mission event for turning onto the next leg of the route.

At this point, Strike Group 1 takes a 45 degree turn to the left and Strike Group 2 takes a 45 degree turn to the right, proceeding on paths that converge on the Red Air Base, target for the strike. The next set of data to be examined is that concerning the detection and attack processes. Data from WGOUT is analyzed with respect to expected outcome based on capabilities assigned in DATBAS.

The first detection of units of the Blue Strike forces occurs at game time 2.280 and at position XPOS 650.95, YPOS 656.24 as shown in Table 4-8. Taking the position of the Red Base at XPOS 587.00, YPOS 720.00, from Table 4-8 the detection range is calculated by the rectangular coordinate method as shown in Table 4-9.

Referring to the SRAD category of DATBAS in Table B-1 of Appendix B, the search radar type assigned to the Red Air Base is BG. Free space detection range of this radar is defined to be 150 NM, with 360 degree coverage. The search radar type assigned to the SAM Base is BH. Free space detection range of this radar is defined to be 70 NM, with 360 degree coverage.

It is of interest to note in Table 4-8 that both the Air Base and the SAM Base detected the BLUE F011 fighter group simultaneously. Although the detection range shown in Table 4-9 is well within the 150 NM range of the Air Base radar, it is a good distance beyond the 70 NM range of the SAM Base radar. This can be explained by looking at the GRUP data

TABLE 4-8

RADAR DETECTION TIMES OF BLUE AIR
BY RED AIR BASE AND RED SAM BASE

```
TIME      2.280
 RED BASE GRUP 199  GDET EVNT  AGST BLUE F011 GRUP  6
 RED GRUP XPOS  587.00 YPOS  720.00
         VELX    0.   VELY    0.
 BLUE GRUP XPOS  650.95 YPOS  656.24
          VELX -343.12 VELY  335.66

TIME      2.280
 RED BASA GRUP 200  GDET EVNT  AGST BLUE F011 GRUP  6
 RED GRUP XPOS  587.00 YPOS  720.00
         VELX    0.   VELY    0.
 BLUE GRUP XPOS  650.95 YPOS  656.24
          VELX -343.12 VELY  335.66
```

TABLE 4-9

DETECTION RANGE OF RED BASE AGAINST BLUE AIR

$$\sqrt{((\text{Red XPOS}-\text{Blue XPOS})^2 + (\text{Red YPOS}-\text{Blue YPOS})^2)} =$$

$$\sqrt{((587.00-650.95)^2 + (720.00-656.24)^2)} = 90.305 \text{ NM}$$

category in DATBAS, where the SAM Base is defined as being collocated with the Air Base. Referring to the Collocated Base definition in the CLM User's Guide, Appendix A, the fact that collocated bases will be attacked as a single target and will respond as a single defensive force is explained.

The fact that the Air Base did not detect the incoming Blue Air group at the maximum range of 150 NM may be due to the strike route profile. Looking at the RTE category of SENSET, the third column contains the altitudes for the route legs. It can be seen that the altitude for the final inbound leg to the target for routes 1 and 2 is decreasing to 5000 feet. This could possibly prevent detection by keeping the Blue Air groups below the radar horizon for the Red Air Base. Table 4-10 shows the effect of the curvature of the earth on detection range of the Red Air Base at an altitude of 0 feet against the Blue Air groups at an altitude of 5000 feet.

TABLE 4-10

EARTH CURVATURE CONSTRAINED RADAR DETECTION RANGE

$$1.229 * (\sqrt{0} + \sqrt{5000}) = 86.903 \text{ NM}$$

While there is a small amount of variation, 3.4 NM, between the results expected from Table 4-10 and the actual detection range from WGOUT, it appears that compensation for earth curvature is applied in the detection process.

Once the incoming Blue Air Group was detected by the Red Air Base, the defensive response was initiated immediately by the collocated SAM Base, as shown by Table 4-11. Each attack (ATTK) and corresponding terminate attack (TMAK) event pair, appearing to occur at the same time, represent the launching of a single surface-to-air missile (SAM) against the Blue Air group that has just been detected.

Further study of the WGOUT file reveals that all 20 of the SAMs assigned to the Red SAM Base were utilized in the defensive response to the first 20 incoming Blue Air groups detected. Once the SAMs were expended, the defensive response shifted to the Red Air Base, which began launching its 12 sections of defensive air fighters. Although the Red Air groups began attacking the Blue Air groups, there was no apparent defensive response by the Blue defensive air fighters to counter-attack the Red fighters.

Attack aircraft of the Blue Strike Groups 1 and 2 carried out their mission, attacking the Red Base, after which the Blue Strike Groups retired by way of the designated egress routes, back to the Blue Carrier.

TABLE 4-11

DEFENSIVE RESPONSE OF RED SAM BASE

```
TIME     2.281
 RED BASA GRUP 200  ATTK EVNT  AGST BLUE F011 GRUP  6
 RED GRUP XPOS  587.00 YPOS  720.00
         VELX    0.   VELY    0.
 BLUE GRUP XPOS  650.60 YPOS  656.58
          VELX -343.12 VELY  335.66

TIME     2.281
 RED BASA GRUP 200  TMAK EVNT  AGST BLUE F011 GRUP  6
 RED GRUP XPOS  587.00 YPOS  720.00
         VELX    0.   VELY    0.
 BLUE GRUP XPOS  650.60 YPOS  656.58
          VELX -343.12 VELY  335.66
```

V. ISSUES OF VALIDATION AND VERIFICATION

The data presentation of the preceding chapter is intended to serve as an illustration for the approach to be used in the process of validation and verification of the CLM. While exhaustive testing of this model would be an enormous task, beyond the scope of this thesis, the basic methods employed in evaluation of the data may be successfully employed in incremental efforts to test the correctness of the many different functions of the CLM.

Initial efforts in the process should be geared toward the validation of the individual functions of the CLM. To accomplish this, simple scenarios should be designed to facilitate testing specific functions in an uncluttered environment. Other factors that recommend this approach are the lengthy running time of the model when large data sets are used and the massive size of the file WGOUT when large data sets and complex scenarios are employed. Using small data sets and simple scenarios results in shorter turnaround times and facilitates evaluation of data in a smaller output data set.

When the basic functions of the CLM have been tested individually, larger, more complex scenarios should be constructed by combining the tested functional components of the original simple scenarios. This will allow the stepwise investigation of any influences the functions may have on each other.

Since the CLM is such a complex model it is probably infeasible to test all possible decision-decision paths that can be generated by a large scenario. There will be a level of complexity reached at some point in the validation and verification process where the diminishing returns gained by detailed evaluation of scenarios of any greater degree of complexity will not justify the effort required.

In retrospect, the scenario evaluated in the previous chapter was too complex for a first level evaluation of CLM functions. With the complex actions of multiple groups involved in the air strike scenario, it is difficult to isolate on a single function and be sure that it is free of interference from the surrounding environment. As noted in the evaluation of scenario data, it is not certain whether the variation observed between the expected and actual positions of the Blue Strike groups was a result of the way the program handles supergroups, or some other interaction. Likewise, it was not clear exactly what effect the collocation of the Red SAM Base with the Red Air Base had on the radar detection range observed.

Specific functional areas to be assessed in the validation and verification process are kinematics, detection, response, attrition, and communication. This effort should include the evaluation of each of these functional areas for sensitivity to error propagation in other functions.

A. KINEMATICS

The kinematic function involves the movement of force groups from one position to another according to mission directives or mission macro instructions contained in SENSET. Components of this function are original position, distance, speed, time, and new position. Errors propagated in this function will have an impact on detection and communication functions. If a group or unit is placed at a destination with a positional error, radar and/or sonar detection range may not produce the results intended by the scenario design. This will also have an impact on the interplay between communication signal strength, jamming, message reception and network performance. The degree of impact depends upon the magnitude of the error and how it propagates during the execution of the program.

B. DETECTION

The detection function involves determination of when a force group or unit falls within the detection parameters of a sensor of another force group or unit. Components of this function are sensor platform position, sensor range, sector coverage, sensor platform orientation, masking, altitude of both sensor platform and target, and target position. Any error propagated in this function will have an effect on response time for defensive reaction by the sensor platform and also any actions to be initiated by other force units based on messages generated in response to the detection.

C. RESPONSE

The response function involves the automatic initiation of defensive measures against groups or units of a designated enemy force. Response occurs whenever an enemy force is detected by sensors or initiates an attack. The defensive response involves the utilization of whatever defensive weapon capabilities are assigned to the unit or group responding, such as point defense, SAMs or the launching of fighters. An example of a complex response would be the detection of inbound enemy aircraft by a remote surveillance aircraft or ship, generating a message to an aircraft carrier, which launches fighters to counter the threat. Errors propagated in any of the functions involving the force units in this detection-relay-response loop could alter the expected outcome in unpredictable ways.

D. ATTRITION

The attrition function involves the removal of units that are tagged as killed in action from any further participation in scenario events. Components of this function are the probability of kill (P_K) tables for weapon versus platform and platform versus platform in the WTBL and PTBL categories of DATBAS, respectively, and the survivability per engagement probabilities in the MISW category of SENSET. Any errors propagated in the interaction between P_k and survivability could result in unexpected outcome from engagements between enemy force groups.

E. COMMUNICATION

The communication function is the centerpiece of the CLM. All other functions provide the means by which events and action states are simulated to generate the communications load. Components of this function are communication doctrine, message types, sending units, receiving units, relay units, signal strength, jamming, and network capacity. The Communication System Model, still under development, is to perform the communication function of the CLM. The Communication System Model is designed to provide the capability to evaluate the performance of many different types of tactical communication networks. Once this module is interfaced to the CLM, its functions will need to be validated for correct response to the action state inputs from the wargame functions of the CLM.

The processes of validation and verification of the CLM will involve making decisions on the level of error propagation to be tolerated. The criteria for these decisions should ultimately be based on the effect of any errors on the communication functions critical to the proper evaluation of network performance.

An important aspect to the validation and verification process is the proper design of scenarios for testing the functions. Close attention to detail is required in construction of the input data files DATBAS and SENSET. Good documentation is necessary to facilitate the translation of a scenario plan into correct user input data. The CLM User's Guide is included as part of this thesis to provide documentation support for the validation and verification effort on the CLM.

VI. CONCLUSIONS AND RECOMMENDATIONS

The primary objective of this thesis has been to investigate the structure and function of the CLM for the purpose of identifying an appropriate methodology for validation and verification. Utilizing the methods demonstrated in this thesis should facilitate the validation and verification effort. Since it is a large and complex model, the process of validating and verifying the CLM and its component functions will be very intensive and time consuming. Assigning teams to carry out the testing of the separate functions should be considered as a reasonable approach to this problem.

The CLM shows excellent potential for development as a tool to evaluate communications network performance. Although originally intended to support JTIDS system development, changes to the CLM are providing the flexibility required to analyze the performance of a variety of communication network systems. Addition of the Communication System Model as a postprocessing module will be a major enhancement to the CLM, allowing complete user specification of communication system parameters.

Development of scenario data sets during the research phase of this thesis effort was hampered by lack of coherent documentation. Solving problems in format and content of the user input data files required searching through existing documentation that lacked indexing, page numbers, and made references to supporting data that did not exist. The existing documentation has also been rendered largely obsolete by the many changes already made to the CLM. This was the main influence for creating the user's guide included in this thesis. It is recommended that a new set of documentation be created for the CLM and maintained to reflect changes made during the ongoing development efforts.

With the ability to support joint service operation scenarios, the CLM exhibits good potential as a joint C^3 training and analysis tool. As such, the CLM would be a valuable addition to the C^3 academic program at the Naval Postgraduate School. With renewed DOD emphasis on joint service operations, the CLM can provide an excellent opportunity to build an experience base through joint service team studies at NPS. In order to facilitate hosting the CLM in the WAR Laboratory at NPS it is recommended that a study be undertaken to evaluate the nature of changes required to host the CLM. Changes to be considered should include both those involving the WAR Laboratory facilities and those involving the CLM itself.

One change that would greatly enhance the portability and maintainability of the CLM would be the translation of the programs into a structured language such as Pascal, Ada, or C. A structured analysis and design of the CLM for such a translation would provide an excellent opportunity for thesis study support at NPS.

Use of this thesis is recommended for anyone desiring to become familiar with the CLM. It is also recommended as a reference for construction of the input data sets, DATBAS and SENSET, in preparing scenarios either for validation and verification work or for further studies of the model and its potential applications.

APPENDIX A

CLM USER'S GUIDE

The information contained in this section is a synthesis of material drawn from the Communication Load Model (CLM) Computer Program Development Specification [Ref. 1], the User's Manual for the Communications Load Model (CLM) [Ref. 2], operational experience with the CLM, and discussions with personnel at the Naval Air Development Center C^3 Lab involved in the CLM project. This guide is intended for use by personnel who have a basic understanding of what the CLM is and how it functions. While intimate familiarity with the CLM is not a requirement for successful use, it is assumed that the user has a clear idea of the problem to which the CLM is applied. To this end it is recommended that the user prepare a "Game Plan" before approaching the scenario construction process. A list of the types of forces and units to be involved and their capabilities should be compiled first. This list may then be translated into the required formats for DATBAS. The most useful planning aid for SENSET is a sheet of graph paper. Laying out the "playing field", a grid with 20 degrees of longitude and 15 degrees of latitude facilitates the placement and disposition of forces. Once the game latitudes and longitudes are assigned to the grid, it is much easier to visually plan routes for Mission Macros and Mission Directives. This avoids a lot of tedious calculations for the required data entries. The purpose of this guide is simply to enable the user to effectively understand and utilize all of the features and functions of the CLM.

A. USER INPUT

User input to the CLM is by way of the files DATBAS and SENSET. DATBAS is, simply, a data base in which all the basic tactical units and their operational parameters are defined. The composition of groups and supergroups made up of these units is also defined in DATBAS. SENSET provides the data that drive the scenario by defining actions, in Mission Macros and Mission Directives to be executed by the supergroups, groups and units involved in the scenario.

1. DATBAS

This is the file in which data descriptions and formats for force structure are entered. There are 21 categories of data that may be entered in DATBAS. Data are entered in 80 column card format, with each line in a category corresponding to a single "card". Each category begins with a header card that contains only the category name of 2, 3, 4, or 5 characters. The card format is only a logical view imposed on the data file, as cards are not actually used. A list of the categories by name, with a short explanation of each is presented here.

Category	Description
UNIT -	Force unit types and capabilities
JTIDS -	Communication equipment types
SRAD -	Search radar types
EW -	Electronic warfare equipment types
SSON -	Search sonar types
LSON -	Localization sonar types
WPN -	Weapon types
JAMM -	Hostile jammer equipment
STGT -	Sonar target table
WTGT -	Weapon target table
PTGT -	Platform target table
DTBL -	Sonar detection range table
WTBL -	Weapon kill probability table
PTBL -	Platform kill probability table
LTBL -	Platform vs platform kill rate table
CASP -	Close air support patterns
SGRP -	Super group composition
GRUP -	Regular group composition
MSGA -	Message types
COI -	Communication communities of interest
MSGL -	Communication doctrine

Two categories which must always have data entered are UNIT and GRUP. The reason for this is that the smallest entity recognized for assignment of mission directives or mission macros is the regular group, even if it consists of only a single unit.

In addition to the format and domain constraints within each category, there are also constraints involving data relationships between the categories. These will be pointed out in the descriptions of the categories and must be carefully observed whenever entries are made in DATBAS. There are also constraints involving relationships between data in DATBAS and declarations made in SENSET that will be noted in this section and also in the section pertaining to

SENSET. Following is a field by field description of data entries for DATBAS.

Data formats are given in abbreviated form. Examples of format types are shown here:

A4 - Alphanumeric, maximum of 4 characters.

I5 - Integer, maximum of 5 digits.

F5.2 - Floating point decimal, maximum of 5 spaces, including decimal point, with 2 places to the right of the decimal

---

UNIT in col. 1-4 of header. A maximum of 200 unit types may be defined.

** "Card" 1 ** NOTE - "MBS" = Must Be Specified

Unit Type Identifier, A2, Col. 4-5; Any uniquely assigned 2 character alphanumeric, at least one of which must be alpha. Unit type is user-defined, may not be blank; MBS.

Unit Combat Class, A4, Col. 7-10; Class identifiers must be drawn from the listing in Table A-1. MBS.

Unit Service ID, A4, Col. 12-15; Service identifiers must be drawn from Table A-2. MBS.

Maximum Speed, I5, Col. 16-20; An integer from 0 to 9,999. Unit is Knots (KT). Default is 0.

Controller/Forward Observer, I5, Col. 21-25; Range in NM. An integer such that: 0 = no controller; < 0 = Forward Observer; > 0 = Controller. Default is 0.
Priority as Target, I5, Col. 26-30; An integer from 1 to 10.1 is highest priority, 10 is lowest. Default is 10.

Killed in Action, F10.2, Col. 31-40; A decimal fraction from 0 to 1. KIA threshold is the attrition level above which a unit is rendered inactive. (e.g. if KIA is set to 0.25, and then the unit is determined to have sustained a 25% or greater casualty, it is tagged as killed in action.) Default is 0.

Size Index, I5, Col. 41-45; An integer from 1 to 7. Size index definitions are found in Table A-3. Default is 0.

NOTE: The remainder of the data entries for UNIT are used to specify unit capabilities. Each identifier is user-defined and must have a corresponding definition entered in the appropriate category. (e.g. if HF is entered in the surveillance radar field, then HF must be defined in the SRAD category.) This is a very useful feature, allowing the user to control unit capability specifications.

JTIDS Terminal Type, I5, Col. 46-50; An integer such that: 0 = no terminal; > 0 = terminal type with send/receive; < 0 = terminal type receive only. Absolute value must be entered in JTIDS category. Default is 0. Not used in current configuration of the CLM.

Surveillance Radar, A2, Col. 54-55; If entered, 2 character identifier must be defined in SRAD. Default is no radar.

Electronic Warfare, A2, Col. 59-60; If entered, 2 character identifier must be defined in EW. Default is no EW sensor.

Surveillance Sonar, A2, Col. 64-65; If entered, 2 character identifier must be defined in SSON. Default is no Surveillance Sonar.

Localization Sonar, A2, Col. 69-70; If entered, 2 character identifier must be defined in LSON. Default is no Localization Sonar.

** "Card" 2 **

# of Anti-Air Weapons, I5, Col. 1-5; An integer > 0 if AAW Weapon is entered. Default is 0.

AAW Weapon Type, A2, Col. 9-10; If entered, 2 character identifier must be defined in WPN. Default is no AAW.

# of Anti-Surface Weapons, I5, Col. 11-15; An integer > 0 if ASUW Weapon is entered. Default is 0.

ASUW Weapon Type, A2, Col. 19-20; If entered, 2 character identifier must be defined in WPN. Default is no ASUW.

# of Anti-Sub Weapons, I5, Col. 21-25; An integer > 0 if ASW Weapon is entered. Default is 0.

ASW Weapon Type, A2, Col. 29-30; If entered, 2 character identifier must be defined in WPN. Default is no ASW.

# of Point Defense Weapons, I5, Col. 31-35; An integer > 0 if Point Defense Weapons is entered. Default is 0.

Point Defense Weapon Type, A2, Col. 39-40; If entered, 2 character identifier must be defined in WPN. Default is no Point Defense Weapon.

Jammer, A2, Col. 44-45; If entered, 2 character identifier must be defined in JAMM. Default is no Jammer. Not used in current configuration of CLM.

Terminal Siting, I5, Col. 46-50; An integer from 1 to 5 where: 1 = very well sited; 2 = well sited; 3 = unsited; 4 = poorly unsited; 5 = very poorly unsited. Default is 1. Not currently used.

Antenna Height, I5, Col. 51-55; An integer ≥ 0. Unit is Feet. Default is 0. Not currently used.

Message Category 1, A2, Col. 59-60; If entered, 2 character identifier must be defined in MSGA. Default is no Message Category specified. Not used in current CLM configuration.

Message Cat 1 Update Rate, F10.2, Col. 61-70; May be blank or 0 if Message Category not specified. Must be FP decimal > 0 if Message Category is specified. Not used in current CLM configuration.

Up to 25 additional Message Category and Update Rate entries may be added on additional "cards".

JTIDS in Col. 1-5 of header. A maximum of 10 terminal types may be defined. Although header card must be included, this data category is not used in the current configuration.

** "Card" 1 **

JTIDS Terminal Type, I5, Col. 1-5; An integer ≥ 1, that corresponds to terminal type declared in UNIT. MBS for each terminal type declared in UNIT.

JTIDS Terminal Class, I5, Col. 6-10; An integer from 1 to 3, where 1 = Class I, 2 = Class II, 3 = Class III. MBS.

Range, I5, Col. 11-15; An integer ≥ 0. Unit is NM. Default is 300 NM.

Transmission Power, F10.2, Col. 16-25; A FP decimal ≥ 0. Unit is Watts. Default is 0.

Antenna Gain, F10.2, Col. 26-35; A FP decimal. Unit is dB. Default is 0.

System Loss, F10.2, Col. 36-45; A FP decimal. Unit is dB. Default is 0.

Receiver Sensitivity, F10.2, Col 46-55; A FP decimal. Unit is dB. Default is 0.

Jamming Threshold, F10.2, Col 56-65; A FP decimal. Assumed unit is dB. Default is 0.

TDMA/DTDMA, I5, Col. 66-70; An integer from 1 to 3, where 1 = TDMA only, 2 = DTDMA only, 3 = both. Default is 1.

SRAD in Col. 1-4 of header. A maximum of 100 Surveillance radar types may be defined.

** "Card" 1 **

Surveillance Radar, A2, Col. 4-5; Each 2 character identifier declared in UNIT must be defined here.

Free Space Max Range, I5, Col. 6-10; An integer from 0 to 999. Unit is NM. Default is 0.

Sector Coverage, I5, Col. 11-15; An integer from 0 to 360. Unit is Degrees. Default is 0, which is the same as 360 andimplies full coverage.

Look Angle Relative to Heading, or True North for Ground Stations (clockwise), I5, Col. 16-20; An integer from 0 to 360. Unit is Degrees. Default is 0.

Masking Angle, I5, Col. 21-25; An integer from 0 to 90. Unit is Degrees. Default is 0.

Beamwidth, F10.2, Col. 26-35; A FP decimal from 0 to 99.99. Unit is Degrees. Default is 0.

Range Resolution, F10.2, Col. 36-45; A FP decimal ≥ 0 and less than 10 NM or defined Free Space Range. Default is no range resolution.

Track Capacity, I5, Col. 46-50; An integer from 0 to 9,999. Default is 0.

Classification Time, I5, Col. 51-55; An integer from 0 to 999. Unit is Seconds. Default is 0.

Update Rate, I5, Col. 56-60; An integer ≥ 0. Unit is Seconds. Default is 0.

EW in Col. 1-2 of header. A maximum of 100 EW Sensor types may be defined. Structure is same as SRAD.

SSON in Col. 1-4 of header. A maximum of 50 Surveillance Sonar types may be defined.

** "Card" 1 **

Surveillance Sonar, A2, Col. 4-5; Each 2 character identifier declared in UNIT must be defined here.

Detection Range Table, I5, Col. 6-10; An integer from 1 to 50 corresponding to the number of the table defined in DTBL for this sonar type. MBS.

Probability of Correct Classification, F10.2, Col. 11-20; A FP decimal fraction. Default is 1.

Average Time to Classify, I5, Col. 21-25; An integer from 0 to 999. Unit is Minutes. Default is 0.

Expected Radius of Localization Probability, F10.2, Col. 26-35; A FP decimal from 0 to 99.99. Unit is NM. Default is 0.

Std. Deviation of Radius of Localization Probability, F10.2, Col. 36-45; A FP decimal from 0 to 99.99. Unit is NM. Default is 0.

Average Time to Localize, I5, Col. 46-50; An integer from 0 to 999. Unit is Minutes. Default is 0.

False Alarm Rate, F10.2, Col. 61-65; A FP decimal from 0 to 999.99. Unit is #/hour. Default is 0.

Update Rate, I5, Col. 61-65; An integer ≥ 0. Unit is Minutes. Default is 0.

LSON in Col. 1-4 of header. A maximum of 50 Localization Sonar types may be defined. Structure is same as SSON.

WPN in Col. 1-3 of header. A maximum of 200 Weapon types may be defined.

** "Card" 1 **

Weapon Type, A2, Col. 4-5; Each 2 character identifier declared in UNIT must be defined here.

Range, I5, Col. 6-10; An integer from 0 to 1000. Unit is NM. Default is 0.

Probability of Kill Table, I5, Col. 11-15; An integer value of: 0 = Lanchester Table, > 0 = Weapon P_k Table, < 0 = Platform P_k Table. Absolute value of entry here must have corresponding entry and definition in respective in LTBL, WTBL, or PTBL respectively.

Weapons per Engagement, I5, Col. 16-20; An integer from 0 to 9,999. The number of missiles or torpedoes to be expended in each engagement. Default is 0.

Firing Rate, F10.2, Col. 21-30; A FP decimal from 0 to 9,999.99. The number of missiles or torpedoes fired/minute. Default is 0.

Speed, I5, Col. 31-35; An integer from 0 to 9,999.99 Speed of missiles or torpedoes in KT. Default is 0.

Minimum Ceiling of SAM, F10.2, Col. 36-45; A FP decimal ≥ 0 and ≤ Maximum Ceiling. Unit is FT. Default is 0.

Maximum Ceiling of SAM, F10.2, Col. 46-55; A FP decimal ≥ Minimum Ceiling and < 100,000 FT. Default is 0.

JAMM in Col. 1-4 of header. A maximum of 25 Jammer types may be defined. Although header must be included, this data category is not used in the current configuration.

** "Card" 1 **

Jammer, A2, Col. 4-5; Each 2 character identifier declared in UNIT must be defined here.

Power, F10.2, Col. 6-15; A FP decimal $\geq$ 0. Unit is Watts. Default is 0.

Antenna Gain, F10.2, Col. 16-25; A FP decimal. Unit is dB. Default is 0.

System Loss, F10.2, Col. 26-35; A FP decimal. Unit is dB. Default is 0.

Antenna Height, I5, Col. 36-40; An integer $\geq$ 0. Unit is FT. Default is Antenna Height declared in UNIT.

STGT in Col. 1-4 of header. A maximum of 7 Sonar Target types may be defined.

** "Card" 1 **

Name of Sonar Target Unit Type 1, A2, Col. 4-5; A 2 character name of a unit type specified in UNIT. Declares Target types to be used in DTBL.
"
"
Name of Sonar Target Unit Type 7, A2, Col. 34-35.

WTGT in Col. 1-4 of header. A maximum of 14 Weapon Target types may be defined.

** "Card" 1 **

Name of Weapon Target Unit Type 1, A2, Col. 4-5; A 2 character name of a unit type specified in UNIT. Declares Target types to be used in WTBL.
"
"
Name of Weapon Target Unit Type 14, A2, Col. 69-70.

PTGT in Col. 1-4 of header. A maximum of 14 Platform Target types may be defined.

** "Card" 1 **

Name of Platform Target Unit Type 1, A2, Col. 4-5; A 2 character name of a unit type specified in UNIT. Declares Target types to be used in PTBL.

"

"

Name of Platform Target Unit Type 14, A2, Col. 69-70.

DTBL in Col. 1-4 of header. A maximum of 50 Sonar Detection Tables may be defined.

** "Card" 1 **

Table Number, I5, Col. 4-5; An integer $\geq$ 1, corresponding to the unique entry for Detection Range Table in SSON for each sonar type. MBS.

** "Card" 2 **

Sprint Speed Detection Range for:

Sonar Category 1 Targets (from STGT), F10.2, Col 1-10; A FP decimal from 0 to 9,999.99. Unit is NM. Default is 0.

"

"

Sonar Category 7 Targets, F10.2, Col 61-70.

** "Card" 3 **

Drift Speed Detection Range for:

Sonar Category 1 Targets (from STGT), F10.2, Col 1-10; A FP decimal from 0 to 9,999.99. Unit is NM. Default is 0.

"

"

Sonar Category 7 Targets, F10.2, Col 61-70.

WTBL in Col. 1-4 of header. A maximum of 200 Weapon P_K Tables may be defined.

** "Card" 1 **

Table Number, I5, Col. 4-5; An integer ≥ 1, corresponding to the unique entry for Probability of Kill Table in WPN for each weapon type. MBS.

** "Card" 2 **

Probability that Weapon Identified by Table Number Will Kill:

Category 1 Targets (from WTGT), F5.2, Col. 1-5; A FP decimal fraction from 0 to 1. Default is 0.
"
"
Category 14 Targets, F5.2, COl. 66-70.

PTBL in Col. 1-4 of header. A maximum of 200 Platform P_k Tables may be defined.

** "Card" 1 **

Table Number, I5, Col. 4-5; An integer ≥ 1, corresponding to the unique entry for Probability of Kill Table in WPN for each platform type. MBS.

** "Card" 2 **

Probability that Platform Identified by Table Number Will Kill:

Category 1 Targets (from PTGT), F5.2, Col. 1-5; A FP decimal fraction from 0 to 1. Default is 0.
"
"
Category 14 Targets, F5.2, COl. 66-70.

LTBL in Col. 1-4 of header. A maximum of 20 Lanchester Tables may must be prepared. Tables 1-10 are for blue capabilities against red and tables 11-20 are for red capabilitiesagainst blue. The unit of measure to describe these capabilities is Units Killed/Minute. The order of the table entries is:

Blue	Red
1.	11. Surface-to-Air Missiles (SAM)
2.	12.Point Defense
3.	13.Artillery

4.   14.Air-to-Surface Missiles (ASM)
5.   15.Surface-to-Surface Missiles (SSM)
6.   16.Submarine
7.   17.Anti-Submarine
8.   18.Defensive Air
9.   19. Offensive Air
10.   20.Close Air Support

** "Card" 1 **

SAM vs Inflight Missile, F10.2, Col. 1-10; A FP decimal from 0 to 999.99. Default is .001.

SAM vs Counter Air, F10.2, Col. 11-20; A FP decimal from 0 to 999.99. Default is .001.

SAM vs Defenseless Air, F10.2, Col. 21-30; A FP decimal from 0 to 999.99. Default is .001.

** "Card" 2 **

Point Defense vs Inflight Missile, F10.2, Col. 1-10; A FP decimal from 0 to 999.99. Default is .001.

Point Defense vs Inflight Missile, F10.2, Col. 1-10; A FP decimal from 0 to 999.99. Default is .001.

Point Defense vs Counter Air, F10.2, Col. 11-20; A FP decimal from 0 to 999.99. Default is .001.

Point Defense vs Defenseless Air, F10.2, Col. 21-30; A FP decimal from 0 to 999.99. Default is .001.

Point Defense vs Ground Elements, F10.2, Col. 31-40; A FP decimal from 0 to 999.99. Default is .001.

** "Card" 3 **

Artillery vs Ground Elements, F10.2, Col. 31-40; A FP decimal from 0 to 999.99. Default is .001.

** "Card" 4 **

ASM vs Ground Elements, F10.2, Col. 31-40; A FP decimal from 0 to 9999. Default is .001.

ASM vs Surface Ships, F10.2, Col. 41-50; A FP decimal from 0 to 999.99. Default is .001.

** "Card" 5 **

SSM vs Ground Elements, F10.2, Col. 31-40; A FP decimal from 0 to 999.99. Default is .001.

SSM vs Surface Ships, F10.2, Col. 41-50; A FP decimal from 0 to 999.99. Default is .001.

** "Card" 6 **

Submarine vs Surface Ships, F10.2, Col. 41-50; A FP decimal from 0 to 999.99. Default is .001.

Submarine vs Submarine, F10.2, Col. 51-60; A FP decimal from 0 to 999.99. Default is .001.

** "Card" 7 **

ASW vs Submarine, F10.2, Col. 51-60; A FP decimal from 0 to 999.99. Default is .001.

** "Card" 8 **

Defensive Air vs Counter Air, F10.2, Col. 11-20; A FP decimal from 0 to 999.99. Default is .001.

Defensive Air vs Defenseless Air, F10.2, Col. 21-30; A FP decimal from 0 to 999.99. Default is .001.

** "Card" 9 **

Offensive Air vs Counter Air, F10.2, Col. 11-20; A FP decimal from 0 to 999.99. Default is .001.

Offensive Air vs Defenseless Air, F10.2, Col. 21-30; A FP decimal from 0 to 999.99. Default is .001.

Offensive Air vs Ground Elements, F10.2, Col. 31-40; A FP decimal from 0 to 999.99. Default is .001.

Offensive Air vs Surface Ships, F10.2, Col. 41-50; A FP decimal from 0 to 999.99. Default is .001.

** "Card" 10 **

Close Air Support vs Ground Elements, F10.2, Col. 31-40; A FP decimal from 0 to 999.99. Default is .001.

Repeat Tables 1 through 10 with numbering 11 through 20 for Red Force capabilities.

CASP in Col. 1-4 of header. A maximum of 10 Close Air Support Patterns may be defined. Patterns must be defined for any units declared as unit type OFFA in UNIT.

** "Card" 1 **

Pattern Number, I5, Col. 1-5; An integer from 1 to 100 uniquely assigned to each pattern. MBS.

Radius Legs 1 and 6, F10.2, Col. 6-15; A FP decimal such that legs 2 and 5 $\leq$ legs 1 and 6 $\leq$ 16. Unit is NM. MBS.

Altitude Legs 1 and 6, F10.2, Col. 16-25; A FP decimal from 0 to 99,999.99. Unit is FT. MBS.

Radius Legs 2 and 5, F10.2, Col. 26-35; A FP decimal such that legs 3 and 4 $\leq$ legs 2 and 5 $\leq$ legs 1 and 6. Unit is NM.

Altitude Legs 2 and 5, F10.2, Col. 36-45; A FP decimal from 0 to 99,999.99. Unit is FT. MBS.

Radius Legs 3 and 4, F10.2, Col. 46-55; A FP decimal such that 0 $\leq$ legs 3 and 4 $\leq$ legs 2 and 5. Unit is NM. MBS.

Altitude Legs 3 and 4, F10.2, Col. 56-65; A FP decimal from 0 to 99,999.99. Unit is FT. MBS.

SGRP in Col. 1-4 of header. A maximum of 500 Supergroups with a maximum of 100 members each may be defined.

** "Card" 1 **

Super Group Identifier, A4, Col. 2-5; A unique 4 character alphanumeric identifier, at least one of which must be of the alpha type. MBS.

Force Identification, A4, Col. 7-10; BLUE or RED. MBS.

** "Card" 2 **

Member Group Identifier, A4, Col. 2-5; Unique 4 character group identifier of a group defined in GRUP category that is a member of this supergroup. MBS.

Radial Displacement, F10.2, Col. 6-15; A FP decimal from 0 to 9,999.99. Distance in NM from center of supergroup. Default is 0.

Angular Displacement, I5, Col. 16-20; An integer from 0 to 360. Measured clockwise from supergroup heading or from due east for ground stations. Unit is DEG. Default is 0.

GRUP in Col. 1-4 of header. A maximum of 2000 groups may be defined. Each group may have a maximum of 21 Unit Types and a maximum of 50 levels of Chain of Command.

** "Card" 1 **

Group Identifier, A4, Col. 2-5; A unique 4 character alphanumeric identifier, at least one of which must be of the alpha type. MBS.

Force Identification, A4, Col. 7-10; BLUE or RED. MBS.

Type Group, A4, Col. 12-15; Group type must be one of the following: BASE = any air base or ground group, SHIP = any ship group, SUB = any submarine group, AIR = any air group. MBS.

Collocated Base, A4, Col. 17-20; 4 character identifier of another group of the type BASE that is collocated with this group (only if it is also of the type BASE). This will cause the collocated bases to be attacked as a single target and to respond as a single defensive force. For example, an air base and a SAM (SHORAD or LORAD) base may be collocated for defensive purposes. Default is no collocation.

Home Base, A4, Col. 22-25; 4 character identifier of a Ship or Base defined in UNIT. Assigned only to a group of AIR type and must have same Force Identifier. MBS for AIR groups.

Next Senior in Chain of Command, A4, Col. 26-30; A 4 character identifier of a group that also has the same force identifier. Reference must be non-circular (i.e. may not report to any group or chain that ultimately reports to this group). Default is top of Chain of Command.

Next Senior for Communication, A4, Col. 32-35; A 4 character identifier of a group that also has the same force identifier. Reference must be non-circular (i.e. may not report to any group or chain that ultimately reports to this group). Default is no communication. This function is not currently used.

Radius of Dispersion, F10.2, Col. 36-45; A FP decimal from 0 to 99.99. Distance in NM from center of group. Default is 0.

Carrier Holding Pattern:

Offset Range, F10.2, Col. 46-55; A FP decimal from 0 to 99.99. Distance in NM from carrier. Default is no holding pattern.

Offset Angle, I5, Col. 56-60; An integer from 0 to 360. Angle in Degrees clockwise from heading of carrier. Default is no holding pattern.

** "Card" 2 **

Number of Type (I) Member Units in Group, I5, Col. 1-5; An integer from 1 to 99 for each of the (I = 1 to 21) unit types in the group. MBS. Each member unit type requires a separate card for the number and type identifier.

Type (I) Unit Identifier, A2, Col. 9-10; The 2 character unit type identifier defined in UNIT. All member units must have same Force identifier and Service identifier. MBS.

MSGA in Col. 1-4 of header. This category is not used in the current configuration, however a header card must be present for proper operation of the Preprocessor.

PMSG in Col. 1-4 of header. This function has been added, but is still under development. Header must be present.

** "Card" 1 **

Enter an integer dummy argument, 3, in Col. 3.

TMSG in Col. 1-4 of header. This function has been added, but is still under development. Header must be present.

** "Card" 1 **

Enter an integer dummy argument, 12, in Col. 2-3.

COI in Col. 1-3 of header. This category is not used in the current configuration, however a header card must be present for proper operation of the Preprocessor.

MSGL in Col. 1-4 of header. This category is not used in the current configuration, however a header card must be present for proper operation of the Preprocessor.

LAST in Col. 1-4 of header. Last "card" of DATBAS, indicates End Of File.

TABLE A-1

UNIT COMBAT CLASS IDENTIFIERS

Combat Class	Description
ASM	Air-to-surface missile
SAM	Surface-to-air Missile
SSM	Surface-to-surface Missile
BOMB	Bomber Aircraft, no ASM, no AAW defense
ASMA	Aircraft w/ASM, no AAW defense
ASMF	Aircraft w/ASM, w/AAW capability
ATK	Attack Aircraft w/AAW capability, no ASM
DEFA	Fighter Aircraft, AAW capable only
FBOM	Fighter/Bomber Aircraft, w/AAW, no ASM
OFFA	Close Air Support Aircraft, w/AAW, no ASM
ASWA	ASW Aircraft, no AAW defense
JAMM	Jammer Aircraft, no AAW defense
RECC	Reconnaissance Aircraft, no AAW defense
SURV	Surveillance Aircraft, no AAW defense
TRAN	Transport Aircraft, no AAW defense
HELJ	Helicopter Jammer, no AAW defense
HELO	Helicopter Gun Ship, w/AAW defense
SSMS	Ship, w/SSM only
SAMS	Ship, w/SAM only
SUAW	ASW Ship, w/SAM and optional LAMPS
SUSW	ASW Ship, w/SSM and optional LAMPS
CG	Cruiser, w/SSM and SAM
DDG	Destroyer, w/SSM and SAM
ASWS	ASW Ship, w/optional LAMPS
DD	ASW Destroyer, w/ optional LAMPS
FF	ASW Frigate, w/ optional LAMPS
CV	Aircraft Carrier, w/ point defense only
LH	Helicopter Landing, Ship w/point defense only
LS	Landing Ship, w/point defense only
PDS	Ship, w/point defense only
SHIP	Ship, no defense
SSBN	ICBM Submarine, no defense
SSWN	Submarine, w/SSM, Torpedo, ASW and ASUW
SSGN	Submarine, w/SSM and ASUW only
SSN	Submarine, w/Torpedo only, ASW and ASUW
AMPH	Marine Amphibious Ship, no defense
LOR	Long Range SAM Site (LORAD)
SHOR	Short Range SAM Site (SHORAD)
ARTD	Direct Support Artillery
ARTG	General Support Artillery
ARM	Armored Vehicle, w/cannon
INF	Infantry Unit, small arms only
PDEF	Base, w/AAW point defense
SUPP	Supply Depot, no defense

TABLE A-1
(continued)

VEH	Vehicle, no defense
MPC	Message Processing Center, no defense
INTL	Intelligence Center, no defense
BASE	Air Base, no defense
CC	Command and Control Center, no defense
COMM	Communication Center, no defense

TABLE A-2

UNIT SERVICE IDENTIFIERS

Identifier	Service
USAF	U. S. Air Force
USA	U. S. Army
USN	U. S. Navy
USMC	U. S. Marine Corps
NATO	North Atlantic Treaty Organization
SUAF	Enemy Air Force
SUA	Enemy Army
SUN	Enemy Navy

TABLE A-3

SIZE INDEX (in Square feet)

1	<1300
2	$1300 - <5200$
3	$5200 - <10400$
4	$10400 - <20800$
5	$20800 - <51600$
6	$51600 - <103200$
7	≥ 103200

2. SENSET

This is the file in which data descriptions and formats for each scenario are entered. There are 9 categories of data that may be entered in SENSET. Data are entered in 80 column card format, with each line in a category corresponding to a single "card". Each category begins with a header card that contains only the category name of 3 or 4 characters. The card format is only a logical view imposed on the data file, as cards are not actually used. A list of the categories by name, with a short explanation of each is presented here.

Category		Description
MISW	-	Miscellaneous Wargame Data
OPTW	-	Wargame Output Options
FORC	-	Initial Locations of Independent Groups
RTE	-	Mission Transit Route Nodes
MMAC	-	Mission Transit Routes
DRTV	-	Preplanned Mission Directives
MISL	-	Miscellaneous CLG Data
OPTL	-	CLG Output Options
MSGS	-	Specific Message Types to be Played (subset of MSGA in DATBAS)

Positioning, routes, missions and profiles are defined for all forces in SENSET. Whereas DATBAS is designed to serve as a general data base for unit types and capabilities, SENSET is specific for each scenario. A separate SENSET file must be created for each scenario, which draws its forces from the units defined in DATBAS. The manner in which units, groups and super groups are defined in DATBAS also has some bearing on how they may be used in SENSET. This and other constraints and relationships will be carefully noted in the following field by field description of SENSET.

MISW in Col. 1-4 of header. Miscellaneous Wargame Data are entered in this section.

** "Card" 1 **

Game Over Time, F10.2, Col. 1-10; FP decimal from .01 to 99.99. Elapsed game time (not real time) in hours at which all action will terminate. MBS.

Maximum Battle Time per Engagement for:

Airborne, F10.2, Col. 11-20; A FP decimal from .01 to 999.99. Elapsed game time in minutes. Default is 0.

ASW, F10.2, Col. 21-30; A FP decimal from .01 to 999.99. Elapsed game time in minutes. Default is 0.

Artillery, F10.2, Col. 31-40; A FP decimal from .01 to 999.99. Elapsed game time in minutes. Default is 0.

Longitude of Grid Center, F10.2, Col. 41-50; A FP decimal from -180 to 180 (positive = East) in Degrees. Default is 0.

Latitude of Grid Center, F10.2, Col. 51-60; A FP decimal from -90 to 90 (positive = North) in Degrees. Default is 0.

Probability Force Group will be Revectored to Attack After Engagement, F5.2, Col. 63-65; A FP decimal fraction from 0 to 1. Default is 0.

Wargame Initial Random Number, I5, Col. 65-70; An Integer from 201 to 599. Default is 201.

** "Card" 2 **

Survivability per Engagement for:

Blue Force Group, F5.2, Col. 1-5; A FP decimal fraction from 0 to 1. Probability of survival per engagement. Default is 1.

Red Force Group, F5.2, Col. 6-10; A FP decimal fraction from 0 to 1. Probability of survival per engagement. Default is 1.

Altitude ASW Rough Localization, F10.2, Col. 11-20; A FP decimal from 0 to 99,999.99. Unit is Feet. Default is 0.

Altitude ASW Fine Localization, F10.2, Col. 21-30; A FP decimal from 0 to 99,999.99. Unit is Feet. Default is 0.

Altitude ASW MAD, F10.2, Col. 31-40; A FP decimal from 0 to 99,999.99. Unit is Feet. Default is 0.

MAD Detection Range, I5, Col. 41-45; An integer $\geq$ 0. Unit is Yards. Default is 0.

Carrier Holding Pattern:

Radius, I5, Col. 46-50; An integer $\geq$ 0. Unit is NM. Default is 0.

Altitude, F10.2, Col. 51-60; A FP decimal from 0 to 99,999.99. Unit is Feet. Default is 0.

Outbound ACLS Cutoff, I5, Col. 61-65; An integer from 0 to 99.99. Unit is NM. Default is 0.

OPTW in Col. 1-4 of header. Wargame Output Options.

** "Card" 1 **

Specify Wargame Information to be Printed for:

DATBAS and SENSET, I5, Col. 1-5; An integer such that 0 = No, 1 = Yes. Default is 0.

Group Sorted Event Files, I5, Col. 6-10; An integer such that 0 = No, 1 = Yes. Default is 0.

Action State Records, I5, Col. 11-15; An integer such that 0 = No, 1 = Yes. Default is 0.

Scenario Event Times to Console Operator, I5, Col. 16-20; An integer such that 0 = No, 1 = Yes. Default is 0.

Line Printer Options, I5, Col. 21-25; An integer from 0 to 7. Refer to Wargame Battle History section, pp A-13 through A-22 in _CLM Computer Program Development Specification_ for definitions. Default is 0.

Line Printer Option Reset Time, F10.2, Col. 26-35; A FP decimal from 0 to 99.99 where 0 = No Reset, > 0 = Scenario Time to Reset. Unit is Hours. Default is 0.

Line Printer Options, I5, Col. 36-40; An integer from 0 to 7. Refer to Wargame Battle History section, pp A-13 through A-22 in _CLM Computer Program Development Specification_ for definitions. Default is 0. Specified options to be used for Reset if specified above.

FORC in Col. 1-4 of header. A maximum of 2000 Force identifiers may be entered.

** "Card" 1 **

Force or Super Group ID, A4, Col. 2-5; A 4 character identifier defined as a Master Super Group or Independent Regular Group in DATBAS (not a member of a Super Group). MBS.

Initial Longitude of Group Center, F10.2, Col. 6-15; A FP decimal from -180 to 180 (positive = East). Unit is Degrees. Default for Air Group = Homebase longitude, all others = 0.

Initial Latitude of Group Center, F10.2, Col. 16-25; A FP decimal from -90 to 90 (positive = North). Unit is Degrees. Default for Air Group = Homebase latitude, all others = 0.

RTE in Col. 1-3 of header. A maximum of 100 Routes may be defined.

** "Card" 1 **

Route Number, I5, Col. 1-5; An integer ≥ 1. MBS.

** "Card" 2 **

Route Points - A maximum of 30 points allowed for each route.

Longitude, F10.2, Col. 1-10; A FP decimal from -180 to 180 (positive = East). Unit is Degrees. Default is 0.

Latitude, F10.2, Col. 11-20; A FP decimal from -90 to 90 (positive = North). Unit is Degrees. Default is 0.

Altitude, F10.2, Col. 21-30; A FP decimal from 0 to 99,999.99. Unit is Feet. Default is Altitude same as previous leg.

MMAC in Col. 1-4 of header. A maximum of 10 Mission Macros may be defined per Force Group. Mission Macros may only be assigned to Groups defined as Air type in the category GRUP in DATBAS.

** "Card" 1 **

Force ID, A4, Col. 2-5; A 4 character identifier defined in FORC. MBS.

Ingress Route Number, I5, Col. 6-10; An integer such that 0 = No Route, > 0 = Specified Route, < 0 = Reverse of Specified Route. MBS. Absolute value of Route Number must be defined in RTE.

Egress Route Number, I5, Col. 11-15; An integer such that 0 = Reverse of Ingress Route, > 0 = Specified Route, < 0 = Reverse of Specified Route. MBS. Absolute value of Route Number must be defined in RTE.

Goal Longitude, F10.2, Col. 16-25; A FP decimal from -180 to 180 (positive = East). Must be a coordinate on specified Ingress Route. May also serve as Mission departure point for AK, SK, CA MMAC or PA Directives. Unit is Degrees. If Goal Longitude is not specified, the Target becomes the default Goal.

Goal Latitude, F10.2, Col. 26-35; A FP decimal from -90 to 90 (positive = North). Must be a coordinate on specified Ingress Route. May also serve as Mission departure point for AK, SK, CA or PA Directives. Unit is Degrees. If Goal Latitude is not specified, the Target becomes the default Goal.

Scenario Time at Goal Position, F10.2, Col. 36-45; A FP decimal from 0 to value entered for Game Over Time in MISW category. Unit is Hours. MBS.4c

Target ID, A4, Col. 47-50; A 4 character identifier defined in FORC. Must be of opposite Force Type. Target ID must be specified for Force Units with AK, SK, or CA Mission Identifiers declared below. Leave blank for PA Mission Identifiers.

Target Longitude, F10.2, Col. 51-60; A FP decimal from -180 to 180 (positive = East). Unit is Degrees. Default is end of Ingress Route.

Target Latitude, F10.2, Col. 61-70; A FP decimal from -90 to 90 (positive = North). Unit is Degrees. Default is end of Ingress Route.

** "Card" 2 **

Ingress Speed, I5, Col. 1-5; An integer from 1 to 9,999.99 and ≤ maximum speed of slowest unit in Force Group. Unit is KT. Default is Ingress Speed of slowest unit.

Egress Speed, I5, Col. 6-10; An integer from 1 to 9,999.99 and ≤ maximum speed of slowest unit in Force Group. Unit is KT. Default is Egress Speed of slowest unit.

Mission Identifier, A2, Col. 14-15; A 2 character identifier where: AK = Attack (Regular Group only), SK = Strike (Super Group only), CA = Close Air Support, PA = Patrol. MBS.

Number of Passes Over Target, I5, Col. 16-20; An integer from 0 to 999.99. Defined for CA only. Default is 2.

CAS Pattern, I5, Col. 21-25; An integer from 1 to 99. Must be a Pattern defined in the CASP category of DATBAS. MBS for CA.

Mission Altitude, F10.2, Col. 26-35; A FP decimal from 0 to 99,999.99. Applies only to AK, SK, and PA. Unit is Feet. Default is 1500.

Mission Speed, I5, Col. 36-40; An integer from 0 to maximum speed of slowest unit. Unit is KT. Default is Ingress Speed.

Length of Major Axis, I5, Col. 41-45; An integer from 0 to 999.99. Applies only to PA. Unit is NM. Default is 0.

Length of Minor Axis, I5, Col. 46-50; An integer from 0 to 999.99. Applies only to PA. Unit is NM. Default is 0.

Inclination of Major Axis, I5, Col. 51-55; An integer from 0 to 180. Unit is Degrees, measured CCW from East. Default is 0.

Elapsed Time for Patrol, F10.2, Col. 56-65; A FP decimal from 0 to the value entered for Game Over Time entered in MISW. Unit is Hours. Default is Game Over Time.

DRTV in Col. 1-4 of header. A maximum of 30 Mission Directives may be defined for each Group or Super Group.

Force Group Identifier, A4, Col. 2-5; A 4 character identifier defined in GRUP or SGRP categories of DATBAS and included in FORC category, but not in MMAC. MBS.

Longitude at which Force Group is to take Next Directive, F10.2, Col. 6-15; A FP decimal from -180 to 180 (positive = East). Unit is Degrees. Default is 0.

Latitude at which Force Group is to take Next Directive, F10.2, Col. 16-25; A FP decimal from -90 to 90 (positive = East). Unit is Degrees. Default is 0.

Elapsed Time Directive in Force, F10.2, Col. 26-35; A FP decimal from 0 to 99.99. Unit is Hours. Default is Game Over Time.

Mission Altitude, F10.2, Col. 36-45; A FP decimal from 0 to 99,999.99. Unit is Feet. Default is 0.

Mission Speed, I5, Col. 46-50; An integer ≥ 0. Unit is KT. Default is 0.

Mission Identifier, A2, Col. 54-55; A 2 character identifier for the mission to be performed during the Elapsed Time as specified above. Refer to Table A-4 for definitions. MBS.

Force Group to be Attacked, A4, Col. 57-60; A 4 character identifier of the Force Group, of the opposite Force, to be taken under attack. Must be defined in SGRP or GRUP category of DATBAS and entered in FORC category. NOTE: For certain Mission Directives there are alternative definitions applied:

For TR, new Chain-of-Command Superior;
For MG, Super Group with which to Merge;
FIRE, Fire on Targets of Opportunity;
TIME, sets Game Time rather than Elapsed Time as Time to Take Next Directive.

JTIDS Status Message to Log, I5, Col. 61-65; An integer such that 0 = No Status JTIDS Message, 1 = JTIDS Status Message, -1 = Radio Silence. Default is 0.

Length of Major Patrol Axis, I5, Col. 66-70; An integer from 0 to 999.99. May be specified only for MC, MS, PA, PB, PE, PF, SC, or HP Mission Directives. Unit is NM. Default is 0.

** "Card" 2 **

Length of Minor Patrol Axis, I5, Col. 1-5; An integer from 0 to 999.99. May be specified only for MC, MS, PA, PF, or HP Mission Directives. Unit is NM. Default is 0.

Inclination of Major Axis to Equator, I5, Col. 6-10; An integer from 0 to 180. Measurement is CCW from East. May be specified only for MS, PA, PF, SC, or HP Mission Directives. Unit is Degrees. Default is 0.

Sequence Number, I5, Col. 11-15; An integer from 1 to 99 unique to Force Group, indicating Sequence of Mission Directive. MBS.

Deployment Offset Range, F10.2, Col. 16-25; A FP decimal from 0 to 999.99. May be specified only for PB, PE, PF, SC, SD, or MG Mission Directives. Unit is NM. Default is 0.

Deployment Offset Angle, I5, Col. 26-30; An integer from 0 to 360. May be specified only for RB, PB, PE, PF, SC, SD, or MG Mission Directives. Unit is Degrees. Default is 0.

CAP Option, I5, Col. 31-35; An integer from -1 to 1 such that -1 = Relief assigned when vectored off CAP, 0 = No relief when vectored, 1 = May not be vectored off

CAP Pattern. May be specified only for PA, PE, or PF Mission Directives.
Number of CAS Passes, I5, Col. 36-40; An integer from 0 to 999.99. May be specified only for RA or CA Mission Directives. Default is 2.

CAS Pattern Number, I5, Col. 42-45; An integer from 1 to 99. May be specified only for RA or CA Mission Directives. MBS.

Cycle Time, F10.2, Col. 46-55; A FP decimal: from 0 to 999.99 Minutes for SD Mission Directive; 0 to 9,999.99 Minutes for MS, MC, FE, or GS Mission Directives; 0 to 100 % for HP Mission Directive.

MISL in Col. 1-4 of header. Miscellaneous CLG Information.

** "Card" 1 **

Initial Random Number for CLG, I5, Col 1-5; An integer from 201 to 599. Default is 201.

Track Correlation on Blue, I5, Col. 6-10; An integer from 0 to 999 such that 0 = No Tracks, 1 = Perfect correlation, one terminal tracks each target, 2 = Two terminals track each target,..., 999 = No correlation, all terminals track each target. Default is 0.

Track Correlation on Red, I5, Col. 11-15; An integer from 0 to 999 such that 0 = No Tracks, 1 = Perfect correlation, one terminal tracks each target, 2 = Two terminals track each target,..., 999 = No correlation, all terminals track each target. Default is 1.

OPTL in Col. 1-4 of header. CLG Output Options. NOTE: OPTL is not used by the CLM in its current configuration. These inputs are requested as prompts when the programs are executed.

** "Card" 1 **

Print Comm Directive and Data Inputs, I5, Col. 1-5; An integer, 0 or 1, where 0 = No, 1 = Yes. Default is 0.

Force Group Position Update, F10.2, Col. 6-15; A FP decimal $\geq$ 0. Unit is Seconds. Default is 12.

Message Statistics Update, F10.2, Col. 16-25; A FP decimal $\geq$ 0. Unit is Seconds. Default is 12.

Output Message Events to Console, I5, Col. 26-30; An integer, 0 or 1, where 0 = No, 1 = Yes. Default is 0.

Initial Line Printer Options, I5, Col. 31-35; An integer from 0 to 3, where 0 = No Line Printer Option, 1 = Message Event Records + Relative Position File, 2 = Option 1 + Action State Records, 3 = Option 2 + Track Information. Default is 0.

Line Printer Option Reset Time, F10.2, Col. 36-45; A FP decimal from 0 to 99.99, where 0 = No Reset, > 0 = Scenario Time to Reset in Hours. Default is 0.
Reset Line Printer Options, I5, Col. 46-50; An integer from 0 to 3, where 0 = No Line Printer Option, 1 = Message Event Records + Relative Position File, 2 = Option 1 + Action State Records, 3 = Option 2 + Track Information. Default is 0.

MSGS in Col. 1-4 of header. This category is not used in the current CLM configuration. However, this header "Card" is required to ensure proper execution of the Preprocessor.

LAST in Col. 1-4 of header. Indicates EOF for SENSET.

TABLE A-4

MISSION DIRECTIVE IDENTIFIER

IN	Inactive, Group currently not in play. Allowed as first directive only. Group positioned at coordinates given in directive (Aircraft placed at Home Base).
RB	Remain Immobile: Land Group static, AF Air Group at Base.
RR	Remain Immobile: Sea Group in port or dead-in-water, Naval Air Group on Carrier or at Land Base.

NOTE: Naval Super Groups should be given a Transit directive of 1 KT speed if such groups are to perform mission operations from a "fixed" position.

RA	Reserve Attack: Attack type Air Group at Base or on Carrier awaiting call to provide Close Air Support.
FE	Fire For Effect: Land Group with Artillery capability either selects & attacks target-of-opportunity or attacks specified Target Group. Group is static. Optionally, group may be used to provide Direct Support Artillery.
GS	Support Artillery: Land Group static awaiting call to provide General Support Artillery Fire.
TR	Transit: Group Transits to specified waypoint.
MC	Circular Hops: Mobile Land Group maneuvers randomly within a circular area.
MS	Linear Hops: Mobile Land Group maneuvers randomly back & forth along a straight path.
PA	Stationary Patrol: Group Patrols either an orbital (point) or rectangular pattern as specified.
PB	Constant Helm: Naval Sea Group proceeds along Super Group SOA while constant helming.
PE	Proceeding Patrol: Air Group flies either an orbital (point) or cross-heading pattern as specified pattern advances with Super Group SOA.

TABLE A-4
(continued)

PF	Sonobuoy Patrol: ASW Air Group flies advancing flank or cross-heading pattern as specified pattern advances with Super Group SOA.
SC	Flank Patrol: Helicopter or Mobile Land Group patrols flank of Land Super Group as it advances. Helicopter Group may perform cross-heading patrol.
SD	Sprint & Drift: Naval Sea Group sprints and drifts while maintaining Super Group SOA.
HP	Helicopter Pops: Helicopter Group pops up & down while Patrolling along a stationary pattern. Red Units turn jammers on when up.
MG	Merge: Regular or Master simple Super Group intercepts & merges with specified Super Group. Group splits off when it takes it next mission directive.
AK	Attack: Regular Group intercepts and engages specified Target Group.
SK	Strike: Super Group intercepts and engages specified Target Group.
CA	Close Air Support: Attack type Air Group flies specified pattern across Targget Group and attacks Target at each pass.
AS	Assault: Landing Craft (boats) shuttle between Mother Ship and beach point.

APPENDIX B

CLM DATA FILES

A. INPUT FILES

The input files DATBAS and SENSET created for the scenario used in this study are listed in this appendix. Table B-1 is the DATBAS listing as used by the CLM. Table B-2 is a subset of DATBAS with amplifying comments for explaining unit types and assigned capabilities. Table B-3 is the SENSET listing as used by the CLM.

B. OUTPUT FILES

An example of the file PROUT is shown in Table B-4. This file is generated by the PREPROCESSOR as a diagnostic for DATBAS and SENSET formatting. Table B-5 contains selected listings from the file WGOUT. The listings shown relate to the scenario events analyzed in the body of this thesis.

TABLE B-1

DATBAS Listing

```
                          DATBAS
   DATA BASE FOR Blue Air Strike vs Red Air Base

UNIT
   BB BASE SUAF    0  150    1      0.75    7    0   BG
                1  100
   FF DEFA SUAF  725    0    3      0.50    1    0   HD
   10  BM    0         0         0              1    0
   BA  LOR SUAF    0  150    1      0.75    7    0   BH
   20  SA    0         0         4   AG         1  100
   SA  SAM SUAF 1200        10       .00    1
   CV   CV  USN   35    0    1       .50    7    3   HV
                                                 1  180
   E2 SURV  USN  314  200    1       .50    1    1   HF
                                                 1
   F1 DEFA  USN  750    0    3       .50    1    2   HB
   20   IC                                       1
   A1 ASMF  USN  800    0    1       .30    1    2   HB
    4   SW   12   B3    0                        1
   B3  ASM  USN  400        10       .00    1

JTID

SRAD
    BG  150  360    0    0     10.00      0.50     50    60
30
    BH    70   360       0    0     10.00      0.50   50    60
30
    HF  250  360    0    0      6.60       0.10   250    20
10
    HB    50   120       0    0      3.30      0.16   10    30
30
    HD  125  140    0    0      3.30      0.25    10      30
30
    HV    50      60    0    0      7.00      0.50   10    60
30

WPN
    B3     3    1   12        12  400
    BM     6    2    4
    IC    10    3    5
    SW     6    4    4
    SA    90    5    2         2 1200       200      60000
    AG     2    6    2
```

TABLE B-1
(continued)

```
WTGT
   A1
   FF
   F1
   E2
   BA

WTBL
    1
          0.10
    2
 0.30      0.30 0.60
    3
      0.90
    4
      0.70
    5
 0.25      0.25
    6
 0.10      0.10

SGRP
 CVG1 BLUE
 C201      0.00    0
 E2C1      0.00    0
 STK1 BLUE
 F011      5.00  350
 F111      5.00  010
 F211      4.00  340
 F311      4.00  020
 A011      2.00  270
 A111      2.00  090
 A211      3.00  225
 A311      3.00  135
 F411      5.00  210
 F511      5.00  150
 STK2 BLUE
 F622      5.00  350
 F722      5.00  010
 A422      2.00  270
 A522      2.00  090
 A622      3.00  225
 A722      3.00  135
 F822      5.00  210
 F922      5.00  150
```

TABLE B-1
(continued)

```
GRUP
 C201 BLUE SHIP           C201 C201      0.10     20.00  020
    1   CV
 E2C1 BLUE  AIR      C201 C201 C201      0.01
    1   E2
 F011 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   F1
 F111 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   F1
 F211 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   F1
 F311 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   F1
 F411 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   F1
 F511 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   F1
 F622 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   F1
 F722 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   F1
 F822 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   F1
 F922 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   F1
 A011 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   A1
 A111 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   A1
 A211 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   A1
 A311 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   A1
 A422 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   A1
 A522 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   A1
 A622 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   A1
 A722 BLUE  AIR      C201 E2C1 E2C1      0.01
    2   A1
 BASA  RED BASE BASE      BASA BASA      0.05
    1   BA
 BASE  RED BASE           BASE BASE      0.05
    1   BB
```

TABLE B-1
(continued)

```
 FF01  RED  AIR      BASE BASE BASE      0.50
    2   FF
 FF02  RED  AIR      BASE BASE BASE      0.50
    2   FF
 FF03  RED  AIR      BASE BASE BASE      0.35
    2   FF
 FF04  RED  AIR      BASE BASE BASE      0.35
    2   FF
 FF05  RED  AIR      BASE BASE BASE      0.50
    2   FF
 FF06  RED  AIR      BASE BASE BASE      0.50
    2   FF
 FF07  RED  AIR      BASE BASE BASE      0.35
    2   FF
 FF08  RED  AIR      BASE BASE BASE      0.35
    2   FF
 FF09  RED  AIR      BASE BASE BASE      0.50
    2   FF
 FF10  RED  AIR      BASE BASE BASE      0.50
    2   FF
 FF11  RED  AIR      BASE BASE BASE      0.35
    2   FF
 FF12  RED  AIR      BASE BASE BASE      0.35
    2   FF

MSGA

PMSG
    3

TMSG
 12

COI

MSGL

LAST
```

TABLE B-2

Unit Capabilities Assigned in DATBAS

Unit types and capabilities are described here. Data fields that are empty or contain zero in the DATBAS file are not included here. For amplifying information, see the user's guide included in this thesis.

UNIT

Red SAM Base

BA - User defined identifier for Red SAM Base.

LOR - Combat class: Long Range SAM site.

SUAF - Service ID: Enemy Air Force

150 - Air controller range in NM.

1 - Priority as a target.

0.75 - Damage threshold for Killed In Action.

7 - Size index.

BG - Surveillance radar: Defined in SRAD.

20 - Number of anti-air weapons.

SA - Anti-air weapon type: Defined in WPN.

4 - Number of point defense weapons.

AG - Point defense weapon type: defined in WPN.

TABLE B-2
(continued)

Surface-to-air Missile

SA - User defined identifier for SAM.

SAM - Combat class: Surface-to-air missile.

SUAF - Service ID: Enemy Air Force.

1200 - Maximum speed in knots.

10 - Priority as a target.

1 - Size index.

Red Air Base

BB - User defined identifier for Red Air Base.

BASE - Combat class: Air base.

SUAF - Service ID: Enemy Air Force.

150 - Air controller range in NM.

1 - Priority as a target.

0.75 - Damage threshold for Killed In Action.

7 - Size index.

BG - Surveillance radar: Defined in SRAD.

TABLE B-2
(continued)

Red Defensive Air Fighters

FF - User defined identifier for Red Fighter.

DEFA - Combat class: Defensive air.

SUAF - Service ID: Enemy Air Force.

725 - Maximum speed in knots.

3 - Priority as a target.

0.50 - Damage threshold for Killed In Action.

1 - Size index.

HD - Surveillance radar: Defined in SRAD.

10 - Number of anti-air weapons.

BM - Anti-air weapon type: Defined in WPN.

Blue Aircraft Carrier

CV - User defined identifier for Blue Carrier.

CV - Combat class: Aircraft Carrier.

USN - Service ID: U.S. Navy.

35 - Maximum speed in knots.

1 - Priority as a target.

0.50 - Damage threshold for Killed In Action.

7 - Size index.

HV - Surveillance radar: Defined in SRAD.

TABLE B-2
(continued)

Blue E-2 Surveillance Aircraft

E2 - User defined identifier for E-2.

SURV - Combat class: Surveillance aircraft.

USN - Service ID: U.S. Navy.

250 - Maximum speed in knots.

200 - Air controller range in NM.

1 - Priority as a target.

0.50 - Damage threshold for Killed In Action.

1 - Size index.

HF - Surveillance radar: Defined in SRAD.

Blue Defensive Fighter

F1 - User defined identifier for Blue Fighter.

DEFA - Combat class: Defensive air.

USN - Service ID: U.S. Navy.

750 - Maximum speed in knots.

3 - Priority as a target.

0.50 - Damage threshold for Killed In Action.

1 - Size index.

HB - Surveillance radar: Defined in SRAD.

20 - Number of anti-air weapons.

IC - Anti-air weapon type: Defined in WPN.

TABLE B-2
(continued)

Blue Attack Aircraft

A1 - User defined identifier for Blue Attack.

ASMF - Combat class: Attack aircraft w/ASM, AAW.

USN - Service ID: U.S. Navy.

800 - Maximum speed in knots.

1 - Priority as a target.

0.30 - Damage threshold for Killed In Action.

1 - Size index.

HB - Surveillance radar: Defined in SRAD.

4 - Number of anti-air weapons.

SW - Anti-air weapon type: Defined in WPN.

12 - Number of anti-surface weapons.

B3 - Anti-surface weapon type: Defined in WPN.

Air-to-surface Weapon

B3 - User defined identifier for "bomb".

ASM - Combat class: Air-to-surface missile.

USN - Service ID: U.S. Navy.

400 - Maximum speed in knots.

10 - Priority as a target.

1 - Size index.

TABLE B-2
(continued)

SRAD (Surveillance Radar Specifications)

BG - Radar type identified for Red Air Base.

150 - Free space detection range.

360 - Sector coverage in degrees.

10.00- Beamwidth in degrees.

0.50 - Range resolution in NM.

50 - Track capacity.

60 - Classification time in seconds.

30 - Update rate in seconds.

BH - Radar type identified for Red SAM Base.

70 - Free space detection range.

360 - Sector coverage in degrees.

10.00- Beamwidth in degrees.

0.50 - Range resolution in NM.

50 - Track capacity.

60 - Classification time in seconds.

30 - Update rate in seconds.

TABLE B-2
(continued)

HF - Radar type identified for Blue E-2.

250 - Free space detection range.

360 - Sector coverage in degrees.

6.60 - Beamwidth in degrees.

0.10 - Range resolution in NM.

250 - Track capacity.

20 - Classification time in seconds.

10 - Update rate in seconds.

HB - Radar type identified for Blue Air.

50 - Free space detection range.

120 - Sector coverage in degrees.

3.30 - Beamwidth in degrees.

0.16 - Range resolution in NM.

10 - Track capacity.

30 - Classification time in seconds.

30 - Update rate in seconds.

TABLE B-2
(continued)

HD - Radar type identified for Red Fighter.

125 - Free space detection range.

140 - Sector coverage in degrees.

3.30 - Beamwidth in degrees.

0.25 - Range resolution in NM.

10 - Track capacity.

30 - Classification time in seconds.

30 - Update rate in seconds.

HV - Radar type identified for Blue Carrier.

50 - Free space detection range.

60 - Sector coverage in degrees.

7.00 - Beamwidth in degrees.

0.50 - Range resolution in NM.

10 - Track capacity.

60 - Classification time in seconds.

30 - Update rate in seconds.

TABLE B-2
(continued)

WPN (Weapon Specifications)

B3 - Weapon type identified for Blue Strike.

3 - Range in NM.

1 - Probability of Kill table number (in WTBL).

12 - Number of weapons per engagememt.

12 - Firing rate (#/min).

400 - Speed in knots.

BM - Weapon type identified for Red Fighter.

6 - Range in NM.

2 - Probability of Kill table number (in WTBL).

4 - Number of weapons per engagememt.

IC - Weapon type identified for Blue Fighter.

10 - Range in NM.

3 - Probability of Kill table number (in WTBL).

5 - Number of weapons per engagememt.

SW - Weapon type identified for Blue Strike.

6 - Range in NM.

4 - Probability of Kill table number (in WTBL).

4 - Number of weapons per engagememt.

TABLE B-2
(continued)

SA - Weapon type identified for Red SAM Base.

3 - Range in NM.

1 - Probability of Kill table number (in WTBL).

12 - Number of weapons per engagememt.

2 - Firing rate (#/min).

1200 - Speed in knots.

200 - Minimum ceiling for SAM (feet).

60000- Maximum ceiling for SAM (feet).

TABLE B-3

SENSET Listing

SENSET
DATA SET FOR Blue Air Strike vs Red Air Base

```
MISW
      10.00       .50     15.00                0.00      0.00 0.50  387
   .25  .80  10000.00   1000.00    100.00  500    5  20000.00    5

OPTW
    1    1    1    1    1      9.99    1
FORC
 CVG1     10.00       3.00
 STK1     10.00       3.00
 STK2     10.00       3.00
 BASA     10.00      12.00
 BASE     10.00      12.00
 FF01     10.00      12.00
 FF02     10.00      12.00
 FF03     10.00      12.00
 FF04     10.00      12.00
 FF05     10.00      12.00
 FF06     10.00      12.00
 FF07     10.00      12.00
 FF08     10.00      12.00
 FF09     10.00      12.00
 FF10     10.00      12.00
 FF11     10.00      12.00
 FF12     10.00      12.00
```

TABLE B-3
(continued)

```
RTE
    1
     10.00       3.00  25000.00
     10.00       6.00  25000.00
     13.00       9.00  18000.00
     10.00      12.00   5000.00
    2
     10.00       3.00  25000.00
     10.00       6.00  25000.00
      7.00       9.00  18000.00
     10.00      12.00   5000.00
    3
     10.00      12.00   5000.00
      9.00      10.00  25000.00
      9.00       5.00  25000.00
     10.00       4.00  17000.00
     10.00       3.00      0.00
    4
     10.00      12.00   5000.00
     11.00      10.00  25000.00
     11.00       5.00  25000.00
     10.00       4.00  17000.00
     10.00       3.00      0.00


MMAC
 STK1     1    3                           2.50 BASE
  480   480   SK
 STK2     2    4                           2.55 BASE
  480   480   SK
```

TABLE B-3
(continued)

```
DRTV
 CVG1    10.00     4.00    10.00      0.00   30   TR         1
         0    1
 CVG1    10.00     5.00    10.00      0.00    1   RB         1
         0    2
 E2C1    10.00     8.00    10.00  25000.00  230   TR         1
              1      0.00    0    0    0    0      0.00
 E2C1     0.00     0.00    10.00  25000.00  230   PE         1   50
    0         2      0.00    0    0    0    0      0.00
 FF01                         0.00      0.00  420   RB
              1      0.00    0
 FF02                         0.00      0.00  420   RB
              1      0.00    0
 FF03                         0.00      0.00  420   RB
              1      0.00    0
 FF04                         0.00      0.00  420   RB
              1      0.00    0
 FF05                         0.00      0.00  420   RB
              1      0.00    0
 FF06                         0.00      0.00  420   RB
              1      0.00    0
 FF07                         0.00      0.00  420   RB
              1      0.00    0
 FF08                         0.00      0.00  420   RB
              1      0.00    0
 FF09                         0.00      0.00  420   RB
              1      0.00    0
 FF10                         0.00      0.00  420   RB
              1      0.00    0
 FF11                         0.00      0.00  420   RB
              1      0.00    0
 FF12                         0.00      0.00  420   RB
              1      0.00    0

MISL
  421  999  999

OPTL
    1     10.00     10.00    1    1      0.00    1

MSGS

LAST
```

TABLE B-4

PROUT Listing

An example of a PROUT file generated during development of the scenario used in this thesis is listed here. The line count errors shown in the Organization Pass Diagnostics are for data categories that are not used, but must have a header entry in the file. In the format diagnostics, the type of error is given, along with the data category in which it occurred. The field in which the error is located is denoted by a line of asterisks, the same length as the defined field, just below the field. This proved to be a most useful diagnostic tool for scenario debugging.

TABLE B-4
(continued)

PROUT

```
16-JUN-87     0:  :     Blue Air Strike vs Red Base

                        ORGANIZATION PASS DIAGNOSTICS
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
: ERROR TYPE : DATA SET   : LINE NO.: DATA CATEGORY : SIZE : SIZE LIMIT :
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
: LINE COUNT : DATA BASE :    149   :     MSGA       : ____ :    ____     :
:............:...........:..........:................:......:.............:
: LINE COUNT : DATA BASE :    150   :     COI        : ____ :    ____     :
:............:...........:..........:................:......:.............:
: LINE COUNT : DATA BASE :    151   :     MSGL       : ____ :    ____     :
:............:...........:..........:................:......:.............:
: LINE COUNT : SCENARIO  :     89   :     MSGS       : ____ :    ____     :
:............:...........:..........:................:......:.............:
```

TABLE B-4
(continued)

```
1
  16-JUN-87     0:  :     Blue Air Strike vs Red Base
 DATA BASE CATEGORY ID TABLE
 ::::::::::::::::::::::::::::::::::::::::::::::::::::::
 : ID # : CATEGORY IDENTIFIER  :  IDENTIFIER LINE #   :
 :......:......................:......................:
 :   1  :        UNIT          :          1           :
 :......:......................:......................:
 :   2  :        JTID          :         20           :
 :......:......................:......................:
 :   3  :        SRAD          :         24           :
 :......:......................:......................:
 :   4  :        EW            :    NOT REQUIRED      :
 :......:......................:......................:
 :   5  :        SSON          :    NOT REQUIRED      :
 :......:......................:......................:
 :   6  :        LSON          :    NOT REQUIRED      :
 :......:......................:......................:
 :   7  :        WPN           :         30           :
 :......:......................:......................:
 :   8  :        JAMM          :    NOT REQUIRED      :
 :......:......................:......................:
 :   9  :        STGT          :    NOT REQUIRED      :
 :......:......................:......................:
 :  10  :        WTGT          :         37           :
 :......:......................:......................:
 :  11  :        PTGT          :    NOT REQUIRED      :
 :......:......................:......................:
 :  12  :        DTBL          :    NOT REQUIRED      :
 :......:......................:......................:
 :  13  :        WTBL          :         43           :
 :......:......................:......................:
 :  14  :        PTBL          :    NOT REQUIRED      :
 :......:......................:......................:
 :  15  :        LTBL          :    NOT REQUIRED      :
 :......:......................:......................:
 :  16  :        CASP          :    NOT REQUIRED      :
 :......:......................:......................:
 :  17  :        SGRP          :         56           :
 :......:......................:......................:
 :  18  :        GRUP          :         80           :
 :......:......................:......................:
 :  19  :        MSGA          :        149           :
 :......:......................:......................:
 :  20  :        COI           :        150           :
 :......:......................:......................:
 :  21  :        MSGL          :        151           :
 ::::::::::::::::::::::::::::::::::::::::::::::::::::::
```

TABLE B-4
(continued)

```
1
  16-JUN-87     0:  :     Blue Air Strike vs Red Base

 SCENARIO SET CATEGORY ID TABLE
:::::::::::::::::::::::::::::::::::::::::::::::::::::
: ID # : CATEGORY IDENTIFIER  :  IDENTIFIER LINE #  :
:......:......................:......................:
:   1  :         MISW         :           1         :
:......:......................:......................:
:   2  :         OPTW         :           4         :
:......:......................:......................:
:   3  :         FORC         :           6         :
:......:......................:......................:
:   4  :         RTE          :          24         :
:......:......................:......................:
:   5  :         MMAC         :          47         :
:......:......................:......................:
:   6  :         DRTV         :          52         :
:......:......................:......................:
:   7  :         MISL         :          85         :
:......:......................:......................:
:   8  :         OPTL         :          87         :
:......:......................:......................:
:   9  :         MSGS         :          89         :
:::::::::::::::::::::::::::::::::::::::::::::::::::::
```

TABLE B-4
(continued)

```
1
  16-JUN-87     0:  :    Blue Air Strike vs Red

                         FORMAT PASS DIAGNOSTICS
:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
: ERROR TYPE : DATA SET  : LINE NO. : DATA CATEGORY : SIZE : SIZE LIMIT :
:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
:F10.2 FORMAT: DATA BASE :    31   :    WPN       :                     :
:    B3    3    1   12         12  400                                  :
:                     **********                                        :
:.......................................................................:
:F10.2 FORMAT: DATA BASE :    35   :    WPN       :                     :
:    SA   90    5    1         1 1200       200     60000               :
:                     **********                                        :
:.......................................................................:
:F10.2 FORMAT: DATA BASE :    35   :    WPN       :                     :
:    SA   90    5    1         1 1200       200     60000               :
:                                    **********                         :
:.......................................................................:
:F10.2 FORMAT: DATA BASE :    35   :    WPN       :                     :
:    SA   90    5    1         1 1200       200     60000               :
:                                              **********               :
:.......................................................................:
1
  16-JUN-87     0::     Blue Air Strike vs Red Base

                         EXTRACTION PASS DIAGNOSTICS
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
: TYPE OF ERROR : DATA SET : LINE NO. : DATA CATEGORY : RANGE LIMITS  :
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
```

TABLE B-5

Selected WGOUT Listings

Output from the wargame campaign activities simulator in the form of time-tagged action states and group positions is in the file WGOUT. Records in this file relating to the activities of the scenario that were investigated are listed here. A brief explanation of the event types will assist the reader in understanding the action state described.

TKOF EVNT - Air Group Takeoff Event

MSSN EVNT - Mission Event (e.g. Strike Group enters route)

OBND EVNT - Outbound Event

GDET EVNT - Sensor Gain Detection Event

ATTK EVNT - Attack Event

TMAK EVNT - Terminate Attack Event

TABLE B-5
(continued)

WGOUT
CLM WARGAME BATTLE HISTORY
FOR DATA SET   Blue Air Strike vs Red Air Base
RANDOM NUMBER SPIN=   444

```
TIME      0.983  BLUE STK1 GRUP   2  TKOF EVNT                                 0
             BLUE GRUP XPOS   599.50 YPOS  210.00 VELX     0.    VELY   0.
             MMBR XPOS   599.50 YPOS  210.00 VELX    -0.50 VELY    30.00
             MMBR XPOS   599.50 YPOS  210.00 VELX    -0.50 VELY    30.00
             MMBR XPOS   599.50 YPOS  210.00 VELX    -0.50 VELY    30.00
             MMBR XPOS   599.50 YPOS  210.00 VELX    -0.50 VELY    30.00
             MMBR XPOS   599.50 YPOS  210.00 VELX    -0.50 VELY    30.00
             MMBR XPOS   599.50 YPOS  210.00 VELX    -0.50 VELY    30.00
             MMBR XPOS   599.50 YPOS  210.00 VELX    -0.50 VELY    30.00
             MMBR XPOS   599.50 YPOS  210.00 VELX    -0.50 VELY    30.00
             MMBR XPOS   599.50 YPOS  210.00 VELX    -0.50 VELY    30.00
             MMBR XPOS   599.50 YPOS  210.00 VELX    -0.50 VELY    30.00
 WRCRD      0.983      1      2      0      4


TIME      0.984  BLUE A011 GRUP  10  TKOF EVNT                                 0

        BLUE GRUP XPOS   599.50 YPOS  210.02 VELX    -0.50 VELY    30.00
 WRCRD      0.984    104     10      0      5
 WRCRD      0.984      1     10      0      5


TIME      0.986  BLUE F511 GRUP  15  TKOF EVNT                                 0

        BLUE GRUP XPOS   599.50 YPOS  210.07 VELX    -0.50 VELY    30.00
 WRCRD      0.986    104     15      0      5
 WRCRD      0.986      1     15      0      5


TIME      0.987  BLUE A211 GRUP  12  TKOF EVNT                                 0

        BLUE GRUP XPOS   599.50 YPOS  210.12 VELX    -0.50 VELY    30.00
 WRCRD      0.987    104     12      0      5
 WRCRD      0.987      1     12      0      5
```

TABLE B-5
(continued)

```
TIME      0.988  BLUE F211 GRUP   8  TKOF EVNT                         0

       BLUE GRUP XPOS  599.50 YPOS  210.12 VELX   -0.50 VELY   30.00
 WRCRD      0.988   104      8      0      5
 WRCRD      0.988     1      8      0      5


TIME      0.988  BLUE A311 GRUP  13  TKOF EVNT                         0
       BLUE GRUP XPOS  599.50 YPOS  210.13 VELX   -0.50 VELY   30.00
 WRCRD      0.988   104     13      0      5
 WRCRD      0.988     1     13      0      5


TIME      0.988  BLUE F111 GRUP   7  TKOF EVNT                         0

       BLUE GRUP XPOS  599.50 YPOS  210.13 VELX   -0.50 VELY   30.00
 WRCRD      0.988   104      7      0      5
 WRCRD      0.988     1      7      0      5


TIME      0.989  BLUE A111 GRUP  11  TKOF EVNT                         0

       BLUE GRUP XPOS  599.50 YPOS  210.16 VELX   -0.50 VELY   30.00
 WRCRD      0.989   104     11      0      5
 WRCRD      0.989     1     11      0      5


TIME      0.989  BLUE F311 GRUP   9  TKOF EVNT                         0

       BLUE GRUP XPOS  599.50 YPOS  210.16 VELX   -0.50 VELY   30.00
 WRCRD      0.989   104      9      0      5
 WRCRD      0.989     1      9      0      5


TIME      0.990  BLUE F411 GRUP  14  TKOF EVNT                         0

       BLUE GRUP XPOS  599.50 YPOS  210.19 VELX   -0.50 VELY   30.00
 WRCRD      0.990   104     14      0      5
 WRCRD      0.990     1     14      0      5

 TIME      0.990  BLUE F011 GRUP   6  TKOF EVNT                        0

       BLUE GRUP XPOS  599.50 YPOS  210.20 VELX   -0.50 VELY   30.00
 WRCRD      0.990   104      6      0      5
 WRCRD      0.990     1      6      0      5
```

TABLE B-5
(continued)

```
TIME     0.994  BLUE STK1 GRUP   2  OBND EVNT  AGST BLUE C201 GRUP   4

        BLUE GRUP XPOS  599.58 YPOS  205.00 VELX    8.00 VELY -479.93
        BLUE GRUP XPOS  599.49 YPOS  210.31 VELX   -0.50 VELY   30.00
             MMBR XPOS  599.64 YPOS  207.48 VELX   40.40 VELY -748.91
        BLUE MMBR XPOS  599.49 YPOS  210.31 VELX   -0.50 VELY   30.00
             MMBR XPOS  599.38 YPOS  205.80 VELX  -19.59 VELY -749.74
        BLUE MMBR XPOS  599.49 YPOS  210.31 VELX   -0.50 VELY   30.00
             MMBR XPOS  599.96 YPOS  205.51 VELX   74.27 VELY -746.31
        BLUE MMBR XPOS  599.49 YPOS  210.31 VELX   -0.50 VELY   30.00
             MMBR XPOS  599.29 YPOS  206.54 VELX  -43.03 VELY -748.76
        BLUE MMBR XPOS  599.49 YPOS  210.31 VELX   -0.50 VELY   30.00
             MMBR XPOS  601.57 YPOS  205.00 VELX    8.00 VELY -479.93
        BLUE MMBR XPOS  599.49 YPOS  210.31 VELX   -0.50 VELY   30.00
             MMBR XPOS  598.53 YPOS  206.36 VELX -197.35 VELY -775.28
        BLUE MMBR XPOS  599.49 YPOS  210.31 VELX   -0.50 VELY   30.00
             MMBR XPOS  601.66 YPOS  207.15 VELX    8.00 VELY -479.93
        BLUE MMBR XPOS  599.49 YPOS  210.31 VELX   -0.50 VELY   30.00
             MMBR XPOS  597.44 YPOS  207.08 VELX    8.00 VELY -479.93
        BLUE MMBR XPOS  599.49 YPOS  210.31 VELX   -0.50 VELY   30.00
             MMBR XPOS  602.29 YPOS  209.49 VELX -381.12 VELY -645.95
        BLUE MMBR XPOS  599.49 YPOS  210.31 VELX   -0.50 VELY   30.00
             MMBR XPOS  597.02 YPOS  209.28 VELX    8.00 VELY -479.93
        BLUE MMBR XPOS  599.49 YPOS  210.31 VELX   -0.50 VELY   30.00
  WRCRD     0.994    21     2     0     4


 TIME     1.033  BLUE STK2 GRUP   3  TKOF EVNT                        0

        BLUE GRUP XPOS  599.48 YPOS  211.50 VELX    0.    VELY    0.
             MMBR XPOS  599.48 YPOS  211.50 VELX   -0.50 VELY   30.00
             MMBR XPOS  599.48 YPOS  211.50 VELX   -0.50 VELY   30.00
             MMBR XPOS  599.48 YPOS  211.50 VELX   -0.50 VELY   30.00
             MMBR XPOS  599.48 YPOS  211.50 VELX   -0.50 VELY   30.00
             MMBR XPOS  599.48 YPOS  211.50 VELX   -0.50 VELY   30.00
             MMBR XPOS  599.48 YPOS  211.50 VELX   -0.50 VELY   30.00
             MMBR XPOS  599.48 YPOS  211.50 VELX   -0.50 VELY   30.00
             MMBR XPOS  599.48 YPOS  211.50 VELX   -0.50 VELY   30.00
  WRCRD     1.033     1     3     0     4
```

TABLE B-5
(continued)

```
TIME      1.033  BLUE F922 GRUP  23  TKOF EVNT                              0

       BLUE GRUP XPOS  599.48 YPOS  211.50 VELX   -0.50 VELY   30.00
 WRCRD      1.033   104     23      0      5
 WRCRD      1.033     1     23      0      5


TIME      1.034  BLUE A422 GRUP  18  TKOF EVNT                              0

       BLUE GRUP XPOS  599.47 YPOS  211.53 VELX   -0.50 VELY   30.00
 WRCRD      1.034   104     18      0      5
 WRCRD      1.034     1     18      0      5

TIME      1.037  BLUE A722 GRUP  21  TKOF EVNT                              0

       BLUE GRUP XPOS  599.47 YPOS  211.60 VELX   -0.50 VELY   30.00
 WRCRD      1.037   104     21      0      5
 WRCRD      1.037     1     21      0      5


TIME      1.037  BLUE A622 GRUP  20  TKOF EVNT                              0

       BLUE GRUP XPOS  599.47 YPOS  211.60 VELX   -0.50 VELY   30.00
 WRCRD      1.037   104     20      0      5
 WRCRD      1.037     1     20      0      5


TIME      1.038  BLUE F822 GRUP  22  TKOF EVNT                              0

       BLUE GRUP XPOS  599.47 YPOS  211.65 VELX   -0.50 VELY   30.00
 WRCRD      1.038   104     22      0      5
 WRCRD      1.038     1     22      0      5


TIME      1.039  BLUE F622 GRUP  16  TKOF EVNT                              0

       BLUE GRUP XPOS  599.47 YPOS  211.66 VELX   -0.50 VELY   30.00
 WRCRD      1.039   104     16      0      5
 WRCRD      1.039     1     16      0      5


TIME      1.039  BLUE A522 GRUP  19  TKOF EVNT                              0

       BLUE GRUP XPOS  599.47 YPOS  211.66 VELX   -0.50 VELY   30.00
 WRCRD      1.039   104     19      0      5
 WRCRD      1.039     1     19      0      5
```

TABLE B-5
(continued)

```
TIME      1.040  BLUE F722 GRUP  17  TKOF EVNT                              0

       BLUE GRUP XPOS  599.47 YPOS  211.69 VELX   -0.50 VELY   30.00
 WRCRD      1.040   104     17      0      5
 WRCRD      1.040     1     17      0      5

TIME      1.044  BLUE STK2 GRUP   3  OBND EVNT  AGST BLUE C201 GRUP   4

       BLUE GRUP XPOS  599.56 YPOS  206.50 VELX    8.00 VELY -479.93
       BLUE GRUP XPOS  599.47 YPOS  211.81 VELX   -0.50 VELY   30.00
            MMBR XPOS  599.69 YPOS  207.93 VELX   43.48 VELY -748.74
       BLUE MMBR XPOS  599.47 YPOS  211.81 VELX   -0.50 VELY   30.00
            MMBR XPOS  599.40 YPOS  208.64 VELX  -16.80 VELY -749.81
       BLUE MMBR XPOS  599.47 YPOS  211.81 VELX   -0.50 VELY   30.00
            MMBR XPOS  601.55 YPOS  206.50 VELX    8.00 VELY -479.93
       BLUE MMBR XPOS  599.47 YPOS  211.81 VELX   -0.50 VELY   30.00
            MMBR XPOS  598.48 YPOS  207.80 VELX -199.64 VELY -774.69
       BLUE MMBR XPOS  599.47 YPOS  211.81 VELX   -0.50 VELY   30.00
            MMBR XPOS  601.18 YPOS  208.58 VELX -564.49 VELY -566.88
       BLUE MMBR XPOS  599.47 YPOS  211.81 VELX   -0.50 VELY   30.00
            MMBR XPOS  597.39 YPOS  208.58 VELX    8.00 VELY -479.93
       BLUE MMBR XPOS  599.47 YPOS  211.81 VELX   -0.50 VELY   30.00
            MMBR XPOS  601.98 YPOS  210.86 VELX    8.00 VELY -479.93
       BLUE MMBR XPOS  599.47 YPOS  211.81 VELX   -0.50 VELY   30.00
            MMBR XPOS  596.99 YPOS  210.78 VELX    8.00 VELY -479.93
       BLUE MMBR XPOS  599.47 YPOS  211.81 VELX   -0.50 VELY   30.00
 WRCRD      1.044    21      3      0      4


TIME      1.046  BLUE STK1 GRUP   2  MSSN EVNT                              0

       BLUE GRUP XPOS  600.00 YPOS  180.00 VELX    8.00 VELY -479.93
            MMBR XPOS  600.95 YPOS  175.11 VELX    8.00 VELY -479.93
            MMBR XPOS  599.21 YPOS  175.08 VELX    8.00 VELY -479.93
            MMBR XPOS  601.43 YPOS  176.28 VELX    8.00 VELY -479.93
            MMBR XPOS  598.70 YPOS  176.23 VELX    8.00 VELY -479.93
            MMBR XPOS  601.99 YPOS  180.01 VELX    8.00 VELY -479.93
            MMBR XPOS  598.01 YPOS  180.01 VELX    8.00 VELY -479.93
            MMBR XPOS  602.08 YPOS  182.16 VELX    8.00 VELY -479.93
            MMBR XPOS  597.85 YPOS  182.09 VELX    8.00 VELY -479.93
            MMBR XPOS  602.44 YPOS  184.38 VELX    8.00 VELY -479.93
            MMBR XPOS  597.43 YPOS  184.28 VELX    8.00 VELY -479.93
```

TABLE B-5
(continued)

```
TIME      1.099  BLUE STK2 GRUP   3  MSSN EVNT                           0

       BLUE GRUP XPOS  600.00 YPOS  180.00 VELX    8.00 VELY -479.93
            MMBR XPOS  600.92 YPOS  175.53 VELX   33.29 VELY -749.26
            MMBR XPOS  599.51 YPOS  177.79 VELX  -22.59 VELY -749.66
            MMBR XPOS  601.99 YPOS  180.00 VELX    8.00 VELY -479.93
            MMBR XPOS  599.17 YPOS  181.64 VELX -201.60 VELY -774.18
            MMBR XPOS  602.55 YPOS  182.23 VELX  707.74 VELY -372.97
            MMBR XPOS  597.83 YPOS  182.09 VELX    8.00 VELY -479.93
            MMBR XPOS  602.42 YPOS  184.37 VELX    8.00 VELY -479.93
            MMBR XPOS  597.43 YPOS  184.28 VELX    8.00 VELY -479.93


TIME      1.421  BLUE STK1 GRUP   2  MSSN EVNT                           0

       BLUE GRUP XPOS  597.00 YPOS  360.00 VELX   -8.00 VELY  479.93
            MMBR XPOS  596.05 YPOS  364.90 VELX   -8.00 VELY  479.93
            MMBR XPOS  597.79 YPOS  364.93 VELX   -8.00 VELY  479.93
            MMBR XPOS  595.57 YPOS  363.73 VELX   -8.00 VELY  479.93
            MMBR XPOS  598.30 YPOS  363.77 VELX   -8.00 VELY  479.93
            MMBR XPOS  595.01 YPOS  360.00 VELX   -8.00 VELY  479.93
            MMBR XPOS  598.99 YPOS  360.00 VELX   -8.00 VELY  479.93
            MMBR XPOS  594.91 YPOS  357.84 VELX   -8.00 VELY  479.93
            MMBR XPOS  599.16 YPOS  357.91 VELX   -8.00 VELY  479.93
            MMBR XPOS  594.57 YPOS  355.62 VELX   -8.00 VELY  479.93
            MMBR XPOS  599.58 YPOS  355.70 VELX   -8.00 VELY  479.93


TIME      1.474  BLUE STK2 GRUP   3  MSSN EVNT                           0

       BLUE GRUP XPOS  597.00 YPOS  360.00 VELX   -8.00 VELY  479.93
            MMBR XPOS  596.05 YPOS  364.90 VELX   -8.00 VELY  479.93
            MMBR XPOS  597.79 YPOS  364.93 VELX   -8.00 VELY  479.93
            MMBR XPOS  594.99 YPOS  360.00 VELX   -8.00 VELY  479.93
            MMBR XPOS  598.99 YPOS  360.00 VELX   -8.00 VELY  479.93
            MMBR XPOS  594.91 YPOS  357.84 VELX   -8.00 VELY  479.93
            MMBR XPOS  599.16 YPOS  357.91 VELX   -8.00 VELY  479.93
            MMBR XPOS  594.57 YPOS  355.62 VELX   -8.00 VELY  479.93
            MMBR XPOS  599.58 YPOS  355.70 VELX   -8.00 VELY  479.93
```

TABLE B-5
(continued)

```
TIME      1.942  BLUE STK1 GRUP   2  MSSN EVNT                           0

       BLUE GRUP XPOS  771.00 YPOS  540.00 VELX  333.61 VELY  345.12
            MMBR XPOS  773.79 YPOS  544.15 VELX  333.61 VELY  345.12
            MMBR XPOS  775.04 YPOS  542.94 VELX  333.61 VELY  345.12
            MMBR XPOS  772.62 YPOS  543.65 VELX  333.61 VELY  345.12
            MMBR XPOS  774.59 YPOS  541.76 VELX  333.61 VELY  345.12
            MMBR XPOS  769.56 YPOS  541.38 VELX  333.61 VELY  345.12
            MMBR XPOS  772.43 YPOS  538.60 VELX  333.61 VELY  345.12
            MMBR XPOS  768.00 YPOS  539.99 VELX  333.61 VELY  345.12
            MMBR XPOS  770.99 YPOS  537.00 VELX  333.61 VELY  345.12
            MMBR XPOS  766.19 YPOS  538.63 VELX  333.61 VELY  345.12
            MMBR XPOS  769.78 YPOS  535.15 VELX  333.61 VELY  345.12


TIME      2.007  BLUE STK2 GRUP   3  MSSN EVNT                           0

       BLUE GRUP XPOS  415.00 YPOS  540.00 VELX -341.28 VELY  337.53
            MMBR XPOS  410.90 YPOS  542.85 VELX -341.28 VELY  337.53
            MMBR XPOS  412.10 YPOS  544.08 VELX -341.28 VELY  337.53
            MMBR XPOS  413.60 YPOS  538.57 VELX -341.28 VELY  337.53
            MMBR XPOS  416.41 YPOS  541.41 VELX -341.28 VELY  337.53
            MMBR XPOS  415.03 YPOS  537.00 VELX -341.28 VELY  337.53
            MMBR XPOS  418.00 YPOS  539.99 VELX -341.28 VELY  337.53
            MMBR XPOS  416.33 YPOS  535.18 VELX -341.28 VELY  337.53
            MMBR XPOS  419.83 YPOS  538.72 VELX -341.28 VELY  337.53


TIME      2.280   RED BASE GRUP 199  GDET EVNT  AGST BLUE F011 GRUP   6

        RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
       BLUE GRUP XPOS  650.95 YPOS  656.24 VELX -343.12 VELY  335.66


TIME      2.280   RED BASA GRUP 200  GDET EVNT  AGST BLUE F011 GRUP   6

        RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
       BLUE GRUP XPOS  650.95 YPOS  656.24 VELX -343.12 VELY  335.66


TIME      2.281   RED BASA GRUP 200  ATTK EVNT  AGST BLUE F011 GRUP   6

        RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
       BLUE GRUP XPOS  650.60 YPOS  656.58 VELX -343.12 VELY  335.66
```

TABLE B-5
(continued)

```
 TIME     2.281   RED BASA GRUP 200  TMAK EVNT  AGST BLUE F011 GRUP   6

        RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
       BLUE GRUP XPOS  650.60 YPOS  656.58 VELX -343.12 VELY  335.66
  WRCRD     2.281    85   200     6   -36


TIME     2.331   RED BASE GRUP 199  GDET EVNT  AGST BLUE F622 GRUP  16

        RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
       BLUE GRUP XPOS  524.98 YPOS  656.36 VELX  331.61 VELY  347.04


 TIME     2.332   RED BASA GRUP 200  GDET EVNT  AGST BLUE F622 GRUP  16

        RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
       BLUE GRUP XPOS  525.31 YPOS  656.71 VELX  331.61 VELY  347.04


 TIME     2.333   RED BASA GRUP 200  ATTK EVNT  AGST BLUE F622 GRUP  16

        RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
       BLUE GRUP XPOS  525.64 YPOS  657.05 VELX  331.61 VELY  347.04


 TIME     2.333   RED BASA GRUP 200  TMAK EVNT  AGST BLUE F622 GRUP  16

        RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
       BLUE GRUP XPOS  525.64 YPOS  657.05 VELX  331.61 VELY  347.04
  WRCRD     2.333    85   200    16   -36


 TIME     2.466  BLUE F111 GRUP   7  GDET EVNT  AGST  RED BASE GRUP 199

       BLUE GRUP XPOS  588.55 YPOS  719.70 VELX -343.12 VELY  335.66
        RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
  WRCRD     2.466     3     7   199     0


 TIME     2.467  BLUE F011 GRUP   6  GDET EVNT  AGST  RED BASA GRUP 200

       BLUE GRUP XPOS  586.99 YPOS  718.81 VELX -343.12 VELY  335.66
        RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
  WRCRD     2.467     3     6   200     0
```

TABLE B-5
(continued)

```
TIME      2.479  BLUE STK1 GRUP   2  MSSN EVNT                          0

       BLUE GRUP XPOS  587.00 YPOS  720.00 VELX -343.12 VELY  335.66
            MMBR XPOS  582.88 YPOS  722.83 VELX -343.12 VELY  335.66
            MMBR XPOS  584.10 YPOS  724.06 VELX -343.12 VELY  335.66
            MMBR XPOS  583.37 YPOS  721.65 VELX -343.12 VELY  335.66
            MMBR XPOS  585.28 YPOS  723.60 VELX -343.12 VELY  335.66
            MMBR XPOS  585.60 YPOS  718.57 VELX -343.12 VELY  335.66
            MMBR XPOS  588.40 YPOS  721.42 VELX -343.12 VELY  335.66
            MMBR XPOS  587.01 YPOS  716.99 VELX -343.12 VELY  335.66
            MMBR XPOS  589.99 YPOS  719.99 VELX -343.12 VELY  335.66
            MMBR XPOS  588.36 YPOS  715.18 VELX -343.12 VELY  335.66
            MMBR XPOS  591.85 YPOS  718.77 VELX -343.12 VELY  335.66


TIME      2.479  BLUE STK1 GRUP   2  ATTK EVNT  AGST  RED BASE GRUP 199

       BLUE GRUP XPOS  587.00 YPOS  720.00 VELX -266.26 VELY -399.38
        RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
            MMBR XPOS  582.88 YPOS  722.83 VELX -172.16 VELY -729.97
        RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
            MMBR XPOS  584.10 YPOS  724.06 VELX -287.36 VELY -692.77
        RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
            MMBR XPOS  583.37 YPOS  721.65 VELX  -99.48 VELY -743.38
        RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
            MMBR XPOS  585.28 YPOS  723.60 VELX -334.67 VELY -671.19
        RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
            MMBR XPOS  585.60 YPOS  718.57 VELX  744.21 VELY -293.52
        RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
            MMBR XPOS  588.40 YPOS  721.42 VELX -668.06 VELY -440.11
        RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
            MMBR XPOS  587.01 YPOS  716.99 VELX  540.61 VELY  589.69
        RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
            MMBR XPOS  589.99 YPOS  719.99 VELX -799.04 VELY   39.24
        RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
            MMBR XPOS  588.36 YPOS  715.18 VELX  228.37 VELY  714.39
        RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
            MMBR XPOS  591.85 YPOS  718.77 VELX -717.06 VELY  219.84
        RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.


TIME      2.479  BLUE A011 GRUP  10  ATTK EVNT  AGST  RED BASE GRUP 199

       BLUE GRUP XPOS  585.60 YPOS  718.57 VELX  744.21 VELY -293.52
        RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
```

TABLE B-5
(continued)

```
TIME     2.479  BLUE A111 GRUP  11  ATTK EVNT  AGST  RED BASE GRUP 199

      BLUE GRUP XPOS  588.40 YPOS  721.42 VELX -668.06 VELY -440.11
       RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.


TIME     2.479  BLUE A311 GRUP  13  ATTK EVNT  AGST  RED BASE GRUP 199

      BLUE GRUP XPOS  589.95 YPOS  719.99 VELX -800.00 VELY    1.73
       RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.


TIME     2.479  BLUE A211 GRUP  12  ATTK EVNT  AGST  RED BASE GRUP 199

      BLUE GRUP XPOS  587.01 YPOS  717.05 VELX   -2.47 VELY  800.00
       RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.


TIME     2.484  BLUE STK1 GRUP   2  TMAK EVNT  AGST  RED BASE GRUP 199

      BLUE GRUP XPOS  586.99 YPOS  719.98 VELX   -2.66 VELY   -3.99
       RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
           MMBR XPOS  583.89 YPOS  719.21 VELX  201.79 VELY -722.34
       RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
           MMBR XPOS  583.45 YPOS  720.45 VELX   12.40 VELY -749.90
       RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
           MMBR XPOS  583.03 YPOS  718.01 VELX  629.67 VELY -407.44
       RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
           MMBR XPOS  584.36 YPOS  719.97 VELX -184.63 VELY -726.92
       RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
           MMBR XPOS  586.40 YPOS  718.65 VELX  796.40 VELY   75.83
       RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
           MMBR XPOS  587.60 YPOS  721.33 VELX -795.13 VELY  -88.15
       RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
           MMBR XPOS  589.02 YPOS  719.47 VELX  510.95 VELY  615.57
       RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
           MMBR XPOS  587.51 YPOS  722.00 VELX -618.16 VELY  507.82
       RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
           MMBR XPOS  589.88 YPOS  718.61 VELX  303.66 VELY  685.78
       RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
           MMBR XPOS  589.63 YPOS  721.78 VELX -445.05 VELY  603.68
       RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
```

TABLE B-5
(continued)

```
TIME      2.485  BLUE STK1 GRUP   2  MSSN EVNT                        0

      BLUE GRUP XPOS  586.98 YPOS  719.98 VELX   -2.66 VELY   -3.99
           MMBR XPOS  584.09 YPOS  718.49 VELX  201.79 VELY -722.34
           MMBR XPOS  583.46 YPOS  719.70 VELX   12.40 VELY -749.90
           MMBR XPOS  583.66 YPOS  717.61 VELX  629.67 VELY -407.44
           MMBR XPOS  584.17 YPOS  719.24 VELX -184.63 VELY -726.92
           MMBR XPOS  587.20 YPOS  718.72 VELX  796.40 VELY   75.83
           MMBR XPOS  586.81 YPOS  721.24 VELX -795.13 VELY  -88.15
           MMBR XPOS  589.53 YPOS  720.08 VELX  510.95 VELY  615.57
           MMBR XPOS  586.89 YPOS  722.51 VELX -618.16 VELY  507.82
           MMBR XPOS  590.18 YPOS  719.29 VELX  303.66 VELY  685.78
           MMBR XPOS  589.18 YPOS  722.39 VELX -445.05 VELY  603.68

TIME      2.486  BLUE STK1 GRUP   2  MSSN EVNT                        0

      BLUE GRUP XPOS  587.25 YPOS  720.38 VELX  266.26 VELY  399.38
           MMBR XPOS  584.53 YPOS  719.10 VELX  436.37 VELY  609.98
           MMBR XPOS  583.98 YPOS  720.24 VELX  519.64 VELY  540.80
           MMBR XPOS  584.08 YPOS  718.23 VELX  418.43 VELY  622.43
           MMBR XPOS  584.70 YPOS  719.78 VELX  527.14 VELY  533.51
           MMBR XPOS  587.15 YPOS  719.52 VELX  -50.28 VELY  798.42
           MMBR XPOS  587.57 YPOS  721.00 VELX  762.52 VELY -241.99
           MMBR XPOS  588.78 YPOS  720.35 VELX -753.07 VELY  269.96
           MMBR XPOS  587.29 YPOS  721.81 VELX  401.82 VELY -691.77
           MMBR XPOS  589.46 YPOS  719.50 VELX -722.34 VELY  201.79
           MMBR XPOS  589.06 YPOS  721.65 VELX -121.80 VELY -740.04



TIME      2.526  BLUE STK2 GRUP   3  MSSN EVNT                        0

      BLUE GRUP XPOS  587.00 YPOS  720.00 VELX  331.61 VELY  347.04
           MMBR XPOS  589.77 YPOS  724.16 VELX  331.61 VELY  347.04
           MMBR XPOS  591.02 YPOS  722.96 VELX  331.61 VELY  347.04
           MMBR XPOS  585.55 YPOS  721.37 VELX  331.61 VELY  347.04
           MMBR XPOS  588.45 YPOS  718.61 VELX  331.61 VELY  347.04
           MMBR XPOS  584.01 YPOS  719.99 VELX  331.61 VELY  347.04
           MMBR XPOS  586.99 YPOS  716.99 VELX  331.61 VELY  347.04
           MMBR XPOS  582.19 YPOS  718.60 VELX  331.61 VELY  347.04
           MMBR XPOS  585.82 YPOS  715.15 VELX  331.61 VELY  347.04
```

TABLE B-5
(continued)

```
TIME     2.526  BLUE STK2 GRUP   3  ATTK EVNT  AGST  RED BASE GRUP 199

        BLUE GRUP XPOS  587.00 YPOS  720.00 VELX -480.00 VELY   -0.00
         RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  589.77 YPOS  724.16 VELX -731.73 VELY -164.55
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  591.02 YPOS  722.96 VELX -747.38 VELY  -62.59
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  585.55 YPOS  721.37 VELX -142.63 VELY -787.18
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  588.45 YPOS  718.61 VELX -667.88 VELY  440.38
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  584.01 YPOS  719.99 VELX  649.47 VELY -467.10
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  586.99 YPOS  716.99 VELX -154.26 VELY  784.99
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  582.19 YPOS  718.60 VELX  735.55 VELY -146.54
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  585.82 YPOS  715.15 VELX   78.46 VELY  745.88
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.


 TIME     2.526  BLUE A422 GRUP  18  ATTK EVNT  AGST  RED BASE GRUP 199

        BLUE GRUP XPOS  585.55 YPOS  721.37 VELX -142.63 VELY -787.18
         RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.


 TIME     2.526  BLUE A522 GRUP  19  ATTK EVNT  AGST  RED BASE GRUP 199

        BLUE GRUP XPOS  588.45 YPOS  718.61 VELX -667.88 VELY  440.38
         RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
```

TABLE B-5
(continued)

```
TIME      2.531  BLUE STK2 GRUP   3  TMAK EVNT  AGST  RED BASE GRUP 199

        BLUE GRUP XPOS  586.98 YPOS  720.00 VELX   -4.80 VELY   -0.00
         RED GRUP XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  586.62 YPOS  722.12 VELX -629.21 VELY -408.16
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  587.37 YPOS  722.11 VELX -730.51 VELY -169.88
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  585.55 YPOS  721.37 VELX    0.   VELY    0.
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  588.45 YPOS  718.61 VELX    0.   VELY    0.
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  584.05 YPOS  719.99 VELX    0.   VELY    0.
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  588.19 YPOS  719.96 VELX  304.77 VELY  739.67
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  585.92 YPOS  718.15 VELX  744.54 VELY  -90.36
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.
             MMBR XPOS  588.06 YPOS  718.16 VELX  446.43 VELY  602.66
         RED MMBR XPOS  587.00 YPOS  720.00 VELX    0.   VELY    0.


 TIME      2.532  BLUE STK2 GRUP   3  MSSN EVNT                         0

        BLUE GRUP XPOS  586.97 YPOS  720.00 VELX   -4.80 VELY   -0.00
             MMBR XPOS  585.99 YPOS  721.71 VELX -629.21 VELY -408.16
             MMBR XPOS  586.64 YPOS  721.94 VELX -730.51 VELY -169.88
             MMBR XPOS  585.55 YPOS  721.37 VELX    0.   VELY    0.
             MMBR XPOS  588.45 YPOS  718.61 VELX    0.   VELY    0.
             MMBR XPOS  584.05 YPOS  719.99 VELX    0.   VELY    0.
             MMBR XPOS  588.50 YPOS  720.70 VELX  304.77 VELY  739.67
             MMBR XPOS  586.66 YPOS  718.06 VELX  744.54 VELY  -90.36
             MMBR XPOS  588.50 YPOS  718.76 VELX  446.43 VELY  602.66
```

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